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THE ANATOMICAL COURSE AND LABORATORY OF THE JOHNS HOPKINS UNIVERSITY.

By Franklin P. Mall, *Professor of Anatomy, Johns Hopkins University.*

Three years have now passed since the teaching of anatomy was begun at the Johns Hopkins University. A number of radical changes were introduced into the course, and during the first year a new anatomical laboratory was constructed. The methods of teaching, as well as the laboratory, I believe to be a success and therefore make the following publication.

The literature on the construction of anatomical laboratories is extremely brief. Descriptions of some of the European institutions have been published in detail, and I have found that by His* the most valuable. He describes a carefully planned building accurately, giving aims and ideals as well as difficulties to be overcome. In America we cannot boast of the multitude of buildings erected especially for the teaching of anatomy and investigation in this subject. This lack is to be the more regretted because we have many problems peculiar to this country. Our students and our climate are both unlike those in Europe, and yet in our many medical colleges the most fundamental branch in medical science is treated in a very shameful way. The dissecting room is as a rule poor, while the laboratory facilities for microscopical study are usually wanting altogether. A few of our leading institutions are marked exceptions to the above statement.

The object of the laboratory is to teach students, to train investigators, and to investigate. Although the first mentioned requires the greater portion of the instructor's time, its importance is by no means as great as the second and third. A subject like anatomy, taught for many centuries, has recently been made a new science through the studies in embryology and histology. The studies in embryology have gradually become more and more comparative in nature, and in turn have influenced to a very great extent our conceptions of comparative anatomy. The great influence of histology is not yet fully felt outside of the study of the higher animals, but its importance has been shown over and over again in the branches fundamental to medicine.

The laboratory method of instruction has become very firmly established in many of our colleges in their undergraduate courses, but in medicine the *results* are yet taught to a great extent by means of lectures. Our problem is the study of the structure and the development of the parts of the human body, utilizing all the methods at our disposal to instill these facts into the student's mind. The aim is to make the course one continuous problem for each student to investigate, aiding each one with good material, and teaching him how to study, wherever necessary.

The instructor soon learns the value of investigation, even in the dissecting room, and with this ideal constantly in view, he soon imparts a portion of it to his students. When anatomy is studied in this way, the student must indeed be stupid not to discover the many defects as well as errors in some of our favorite English text-books.

No subject has been taught more carefully nor in greater detail than anatomy. It has been taught by the greatest minds, and has been presented by means of printing and

*His, Zeit. f. Anatomie, Bd. II, 1877.

engraving ever since these arts have been invented. Yet in looking over the history of men like Vesalius and John Hunter, one is struck with the fact that they taught it from the human body. They had their battles to fight and even to risk their lives to procure human bodies for dissection. They had to antagonize the prejudice against dissection at that time, as many of us in America must to-day.

But with all the good examples shown us by our great predecessors, the tendency has been to teach more and more by means of lectures; and although dissection has grown very popular, it is usually done very poorly and sometimes not at all. In Europe the lecture courses have, in many universities, become gigantic in extent, and the only thing which can stop any of them is a total lack of students.

I have asked many professors, even of anatomy, where they had learned their anatomy, and in nearly all cases the reply was "in the dissecting room." They all admitted that in addition to demonstrations, lectures were of little use to students, and some believed them worse than useless. The zoölogists and botanists have long ago learned the absurdity of the lecture method of teaching, but the anatomist patiently keeps up this slow and stupid method of instruction. It is stupid because no anatomist would use this same method if he were to learn instead of to teach.

We know very well that the burden of responsibility is removed, to a great extent, if the instructor goes over the whole subject carefully once a year. He then can tell his student to go to the dissecting room to see for himself. If the student does not attend the lectures, the professor carries no responsibility, no matter how uninteresting or uninstructive they may be. Yet the beauty of the courses of lectures is that the professor carries no responsibility if the student does not know his anatomy.

I believe that there is but one way to learn any subject, and that is through study. The very name *student* tells what the person so named should be doing; and with a natural science, dealing with a most complex object, extending through the three dimensions of space, any other method besides studying the object itself is practically useless.

Lectures with demonstrations are certainly valuable—more valuable than the lectures with text-books alone. Yet analyzing the object itself is infinitely more valuable than to watch the results exposed by another. Wrestling with the part which is being studied, handling it and viewing it from all sides, and tabulating and classifying the parts worked out, give us the greatest reward. All this may be accomplished by practical laboratory work. If we can make the student work thoughtfully and carefully, a great result is achieved. It makes of him an artist, an actor, an expert, not a dilettant. He is upon the stage, not in the audience.

If, now, all the energy which is expended in conducting extensive lectures is employed in managing a dissecting room, we will find to our astonishment that this ideal can be reached in a certain number of cases. It is not difficult to keep account of the many details of the work, for there are many people in business who easily manage much greater accounts with precision. So this difficulty must be placed aside as one easily overcome. In our laboratory we can tell, though asked at almost any time, what any of the 70 students have done during the year. Also we can give the complete history of any of the subjects dissected. For instance, in Subject No. 70 the first lumbar nerve arose in such-and-such a way and was distributed through the branches to certain regions. It was dissected by Mr. Smith during a certain month. There were in this subject 24 vertebræ; it was white; a male, about 50 years old; was embalmed with carbolic acid and had been in cold storage for 15 months, etc. Mr. Smith's dissection was excellent, good, indifferent, or bad; his knowledge of the subject was also excellent, good, indifferent, or bad; he dissected certain parts poorly, others well, and so on. These records are all kept by the various instructors and are finally recorded upon cards, each representing the part dissected. This method is carried through for osteology, histology, neurology, and embryology, and finally, when the student appears for examination, we have his complete record before us.

In arranging the course on anatomy at this University, very great stress was laid upon the microscopical work. Although this course is conducted separately and independently of that in gross anatomy, they are, however, adjusted to each other in every respect. Much of the advance in modern anatomy is due to the microscope, and we believe that if an anatomical course is robbed of this sub-department it loses its most important support.

In many of the medical institutions of this country, histology is not in charge of the department of anatomy, and often is not represented at all, or at best by too brief a course.

In Europe, histology is often an independent department (as in Austria), or it is frequently subordinate to physiology. There is no harm whatever in giving a histological course in departments other than anatomy, but anatomy must not be robbed of its privilege of conducting such a course. Histology has found its home principally in Germany, and in that country every anatomical institute has associated with it histology.* Waldeyer says that anatomical instruction and research should be carried on as far as possible with the naked eye and then continued with the microscope.† This has been our ideal in the planning of our course and in the construction of our laboratory. When a course is conducted in this way it requires much space, extensive apparatus and a large number of instructors. In Leipzig much space is saved in utilizing the same room for both courses: anatomy in the winter and histology in the summer.‡ This gives an abundance of room for microscopical work, for in all cases more space is required for the course in gross anatomy than for histology. In the Leipzig laboratory a special room containing a floor space of 114 square metres had been constructed for histology, but it was found to be too small, and the course had to be transferred to the large dissecting room, which contains 210 square metres floor space. In Berlin 200 students must be accommodated, and two parallel courses are given in a room containing 153 square

*See Waldeyer in Die Deutschen Universitäten (Report to the University Exhibit at Chicago, 1893), Berlin, 1893, Bd. II.

† Waldeyer, Wie soll Man Anatomie lehren und lehrnen, Berlin, 1884.

‡ His, Zeitschrift für Anatomie und Entwicklungsgeschichte, 1877.

metres of floor space.* But Waldeyer deplores the fact that they are cramped in space, which is a very serious difficulty.

Our histological laboratory has an area of 150 square metres, and is intended to accommodate 50, or at the highest 60 students. If necessary other rooms may be used for the same purpose, which will enable us to instruct a much greater number in histology. Each student is supplied with a working place and locker, containing in addition to Leitz microscope II with Abbe condenser, a suitable dissecting microscope. All the necessary reagents are obtained in the laboratory. The course extends through 15 hours each week, from October 1 to March 15, but most students do some work during odd hours, as the laboratory is open all day.

The aim, throughout the course, is to begin with the fresh tissues, and to end ultimately with many of the complex methods in demonstrating the structure of difficult organs, like the brain. Suitable charts, models, dissections as well as projection of specimens are employed whenever necessary. In a general way we dissect as far as possible in the dissecting room, and continue with the microscope in the histological laboratory.

During the first year a practical course was given in the embryology of the chick, but it was found unnecessary to continue this with many of the students, as most of them have had an extensive course on embryology before they begin the study of medicine. However, embryology is alluded to frequently in our courses in practical anatomy and histology, and each organ is also presented from the standpoint of histogenesis.

Our laboratory has been designed especially to carry out our ideals, and during its construction we have constantly kept before us the following points:

Light.

Heat and ventilation.

Basement planned to manage heat and for the reception of anatomical material.

Cold storage and embalming rooms.

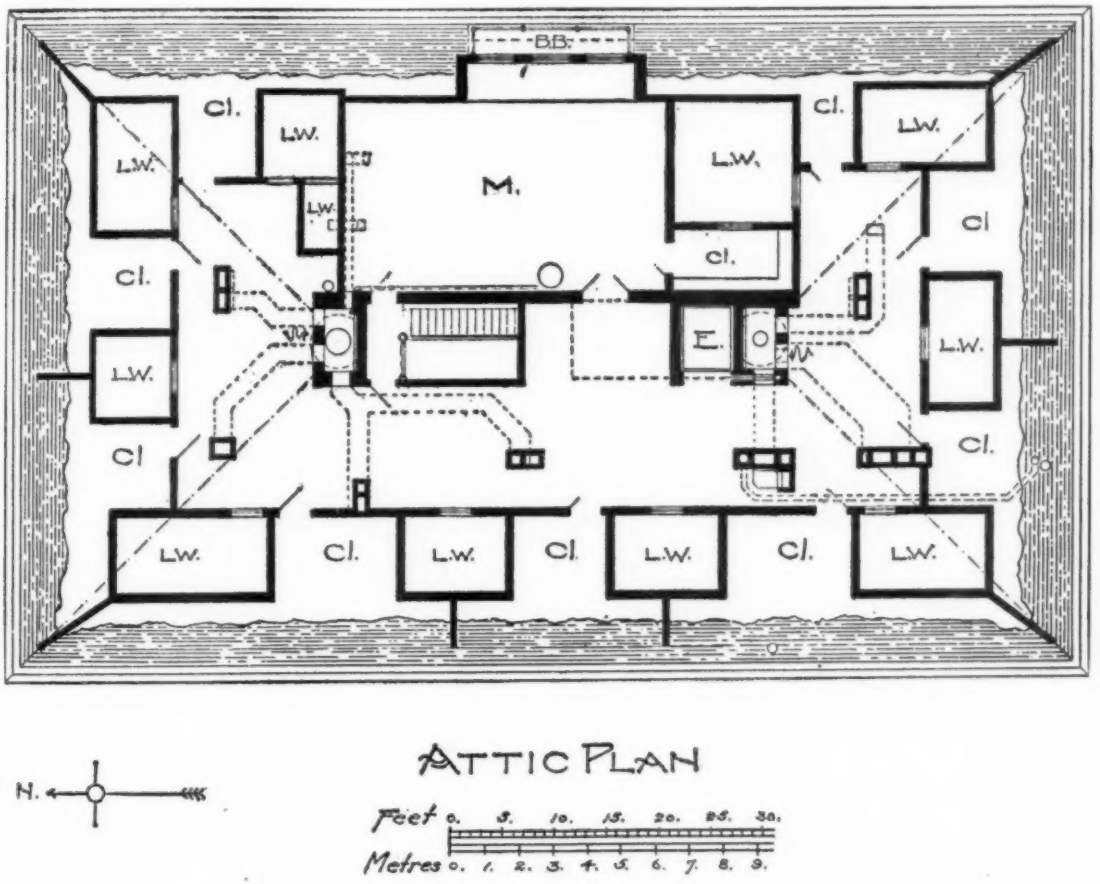


FIG. 13.

M, Macerating room. *LW*, Light well. *Cl*, Closets. *E*, Elevators. *BB*, Bleaching balcony.
The dotted rectangle as well as the square over the stairs mark the light wells in the central portion of the building.

*Die Anstalten und Einrichtungen des öffentlichen Gesundheitswesens in Preussen, 1890.

First floor, lecture room, etc.

Second floor for histology, which was planned in connection with the work on anatomy.

Photography, dark room for reconstruction, chart-making, etc.

Research and preparation room. Private rooms.

Third floor to contain a multitude of dissecting rooms, each complete in itself.

A study room.

Models displayed in the rooms when needed.

Suitable lockers and rooms for the use of students.

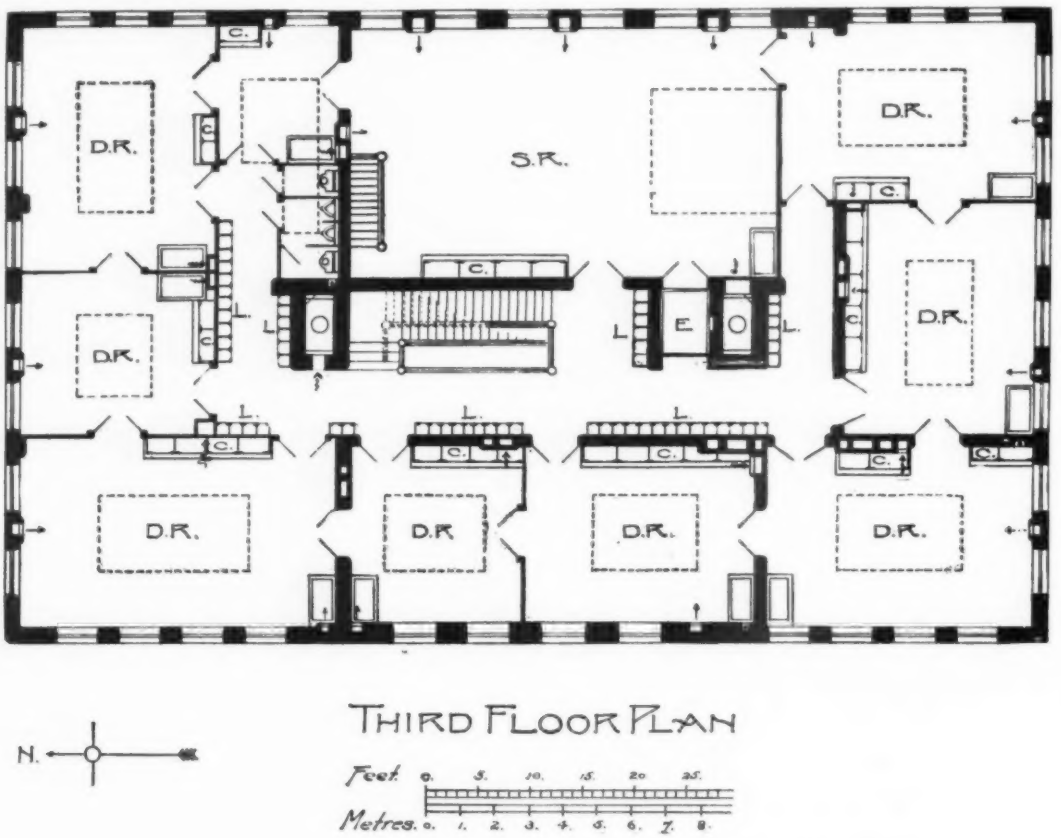


FIG. 10.

DR, Dissecting room. *SR*, Study room. *C*, Cases. *L*, Lockers. *E*, Elevators.
The dotted rectangles around *DR* indicate the extent of the light wells. The lighter partitions indicate that the walls are thin and can be removed easily.

An abundance of storerooms. Storeroom for combustibles.

Animal house and aquaria.

Bone room.

Light.—The great majority of laboratories are very poorly lighted, and this is a very serious defect. In many of the American medical colleges the dissecting room is on the top floor, with an additional skylight. This is a most superior method of illumination, and we have adopted it not only in this laboratory but also in the pathological.

First and foremost in the building is a great central light shaft, in which are placed the stairs and the elevator (see Fig. 13). This gives an abundance of light for the stairs and the upper floors, but we did not trust to this light alone for the illumination of the halls. There are about as many windows as possible in the building. They are wide, and reach nearly to the ceiling, thus giving ample side light for each room. The large rooms on the north side receive light from all three sides, thus making it possible to work with the microscope in any part of the room. Over each door entering the hall there are large transom windows, which aid in the illumination of the halls. On the first floor the hall is illuminated with a special window, thus giving all of the halls throughout the building splendid light.

Each room on the third floor has, in addition to this abundance of side light, a large skylight (see Figs. 10 and 13). The rooms are protected from the cold by a special layer of glass on the level with the ceiling. These light shafts communicate with the attic floor by means of windows, which give additional light to this floor, and give an entrance to this shaft from the inside of the building to clean the skylights.

The balcony on the fourth floor connects with the fire escapes as well as with the roof, so it is possible to go to any portion of the building as well as through the ventilating shafts without constructing any scaffolding or breaking any of the walls.

Heat and Ventilation.—The heating and ventilating systems of the building are very perfect. Cold air, obtained through the windows of the basement, is heated by means of steam coils and then allowed to pass to the rooms through shafts in the outside walls. The Arabic figures in the Basement Plan indicate the floors with which the shafts communicate, 1, to the first floor, and so on. Each room in the building has its own hot-air shaft, and in no case does one shaft go to two stories. There is an abundance of heat, which can be cut off from the room or from the basement, as will be described further on (see Fig. 1).

The ventilating system is by means of two large central shafts, which grow larger and larger as the top of the building is reached, to make room for the additional air entering the shafts from the upper floors. In the center of the north shaft is the smokestack, and in the other the steam exhaust from the engine. In addition to these pipes there is a steam coil in each shaft which aids to heat the air in the shaft, making a constant upward current of air (see various Ground Plans).

In all cases the communication with the shaft is near the floor of the room and on the side of the room opposite the entrance of warm air. The ventilating registers of the larger rooms near the shaft enter it directly, while those somewhat distant pass up the partition walls and communicate with the shaft immediately below the roof (see Fig. 13).

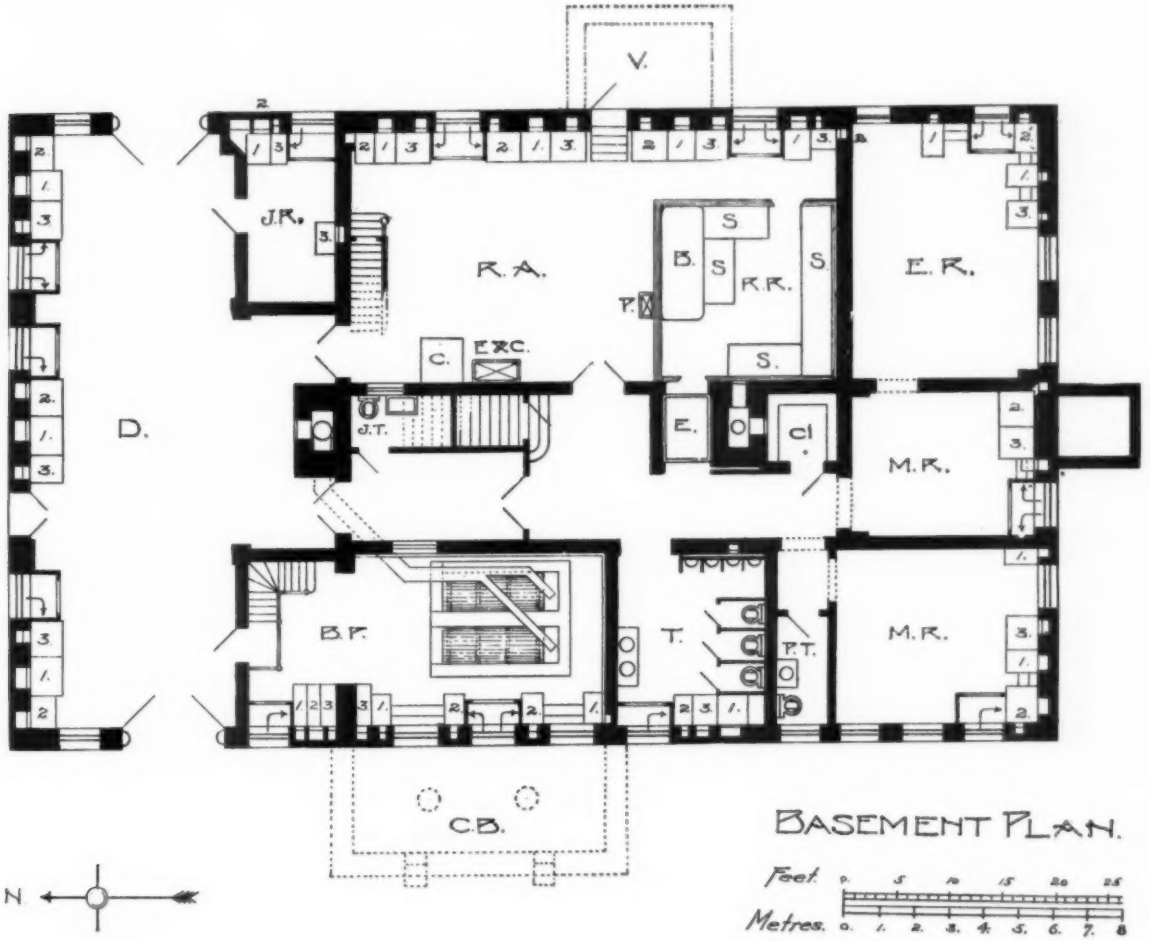


FIG. 1.

D, Driveway. *RA*, Refrigerating apparatus. *C*, Condenser. *E & C*, Engine and compressor. *P*, Pump. *B*, Brine tank. *RR*, Refrigerating room. *S*, Shelves. *ER*, Embalming room. *MR*, Machine room. *BP*, Boiler pit. *T*, Toilet. *PT*, Private toilet. *E*, Elevator. *Cl*, Closet. *JT*, Janitor's toilet. *JR*, Storage room. *V*, Chemical vault. *CB*, Coal bins.

The figures 1, 2 and 3 in the boxes communicating with the hot-air shafts indicate that the shafts communicate with the first, second and third floors respectively.

During two years' experience we have never had gases or odors to enter the shaft and to come out again on the floor above or below, as the suction force of the shaft is sufficient to carry everything entering it to the outside of the building.

The macerating room as well as all of the closets have their own special ventilating shafts communicating with the roof, as the laws of Maryland prevent their being connected with the main shaft.

The elaboration of the building was made by Mr. Archer,* and that of the heating system by Mr. Newton of the firm of Bartlett, Hayward & Co.† I am under obligations to Mr. Archer for the interest he has taken in our problem, as well as the willingness he has shown in adopting plans to overcome our difficulties.

The Basement.—The basement is partly above ground on the south, and wholly above ground on the north side. Its plan is shown in Fig. 1. On the north side there is a drive, *D*, through the whole building, which facilitates the handling of bulky apparatus as well as the reception of anatomical material. This drive is one of the most practical arrangements of the whole building. Very close to the drive is a sub-basement containing the boilers, *BP*. Communicating with the boiler pit is an arched vault, *CB*, extending below the sidewalk, which can be filled with fuel from the street. A hall extends through the basement, and from this the elevator, *E*, communicates with all the floors above. In addition to this there are the embalming room *ER*, the engine room *RA*, storage rooms *JR* and *CL*, cold storage vault *RR*, chemical vault *V*, machine shops *MR*, and toilet rooms *T*. The dark parts of the basement and the vaults are illuminated with electric light.

The whole system of heating, as well as the hot and cold water pipes and drainage, are all exposed in the basement. Nothing is buried and out of reach. A certain number of windows are utilized to obtain the air from the outside, by boxing them off with a large second window. This space communicates by means of large shafts with the sheet-iron boxes containing the steam coils. From these boxes the hot air passes through the hot air shafts to the various floors above, as indicated by the figures 1, 2 and 3. Each room is heated with its own shaft, and each shaft has its own hot air box. The circulation of hot air can be regulated from the room above as from the hot air shaft below. Moreover, the steam for any shaft or set of shafts can be cut off by closing the valve of the steam pipe passing to the respective hot air boxes

There are two boilers, either or both of which may be run at high or low pressure without interfering with the heating apparatus. Whenever it is necessary to operate the engine it is necessary to run at least one boiler at high pressure. The capacity of the boilers and engine is sufficiently large to operate any machinery we may need in future.

The garbage of the building is all cremated in the basement.

*Mr. George Archer, Central Savings Bank Building, Baltimore, Md.

†Bartlett, Hayward & Co., Baltimore, Md.

The Preservation of Anatomical Material.—The supply of anatomical material for dissection and the laws regulating it in Maryland are such that it influences materially the plan of our course in anatomy. Not only is the material scarce, but our most abundant supply is obtained during the summer months when the weather is extremely warm. These facts compel us to resort to rigid methods in its preservation as well as in its dissection.

We have tried a great variety of methods to embalm bodies and find none more excellent than the carbolic acid mixtures. Even the formaldehyde solutions appear to be inferior to it. I prefer to use enough carbolic acid to coagulate all of the muscles, as this destroys the odors completely, and then the parts will not decompose while they are being dissected. This is accomplished with about one kilogram of the pure acid diluted sufficiently with alcohol and glycerin. It is well to mix them in thirds, or in the ratio of one of acid to two of glycerin and two of alcohol. Simply injecting this fluid into a large artery with a syringe by no means sends the fluid to all parts of the body in every case. It is necessary to inject it gradually under a constant pressure. In our laboratory we have a constant pressure apparatus in the embalming room, which can be regulated with ease up to two atmospheres (Fig. 2). About 5 to 7 lbs. to the inch pressure are usually sufficient to distend all the arteries of the body thoroughly. With this pressure about 4 to 6 quarts of the fluid is gradually forced into the femoral artery. A double cannula is employed, injecting both the peripheral and central ends at the same time. It is easy to tell by the appearance of the skin when the body is well injected. The coagulation in the skin about the neck and arms usually appears first, then the face, and finally that of the leg opposite the one in which the femoral has been cut. These marks indicate that the deeper parts have been well injected.

The body is now allowed to remain in the room for from 12 to 24 hours, when the second injection is made to color the arteries. I have never fully understood why the Europeans have had such difficulty in filling the arteries to their satisfaction for the dissection room. I find plaster of Paris colored with red lead eminently satisfactory; it is easily handled and never flows from a cut vessel. We inject a *very* fluid plaster colored with red lead under a high pressure (about 10 lb. to the square inch). Two quarts of this fluid will flow into the arteries in the course of a minute or two, and then it is immediately allowed to flow out. This procedure distends all of the small arteries and leaves practically no plaster in the large vessels, for the plaster remains in the small arteries but flows out again from the large ones.

Subjects treated in the above-mentioned manner can be kept for a long time in almost any fluid, and also in an ordinary ice-box (40° F.). I have kept them in the latter for over a year, but there is a tendency for the feet and hands to mould. These are not perfect methods, and when they are employed they have a marked tendency to make the dissecting-room disagreeable and dirty.

When well embalmed subjects are placed in cold storage (below 32° F.) they may be preserved indefinitely. Yet, simply freezing the subject does not accomplish the object

FIG. 2. INJECTING APPARATUS IN THE EMBALMING ROOM.

The upright tank is connected with the water main, from which it is filled, thus giving a large quantity of compressed air. This is used to drive the embalming fluid into the arteries.

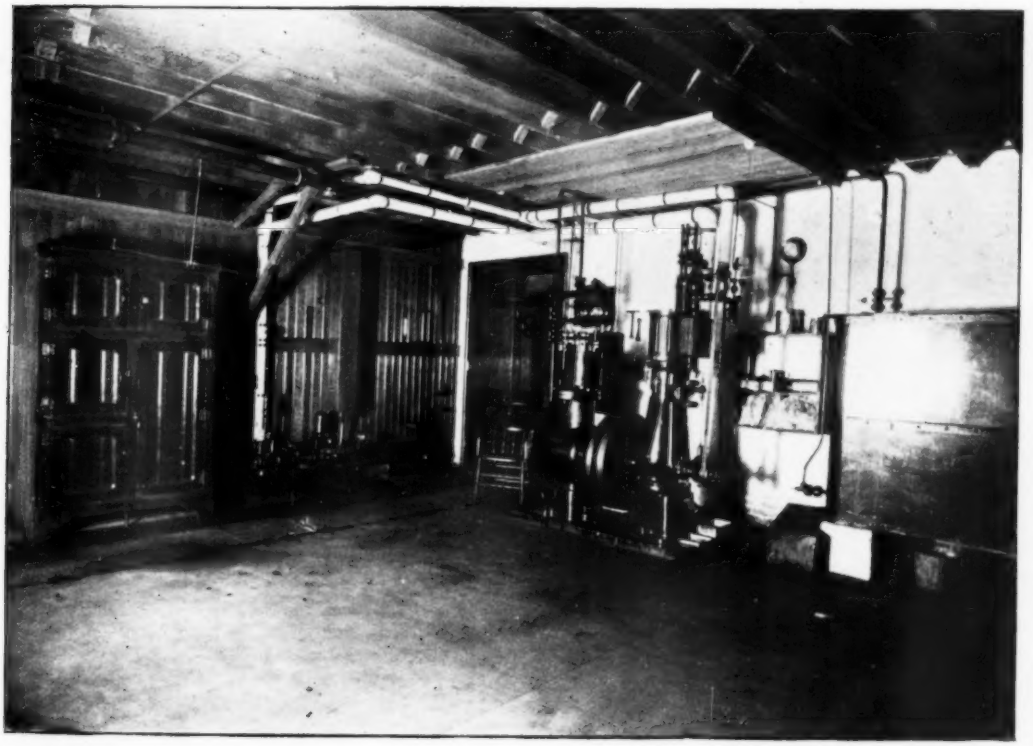


FIG. 3. FLASH-LIGHT PHOTOGRAPH OF THE REFRIGERATING APPARATUS IN THE BASEMENT.

The vault is on the left, as indicated in the sectional view, Fig. 4.

perfectly. We are in the habit of believing that cold air is dry and will prevent evaporation, but even at a very low temperature (20° F.) there is a marked evaporation. Our vault is cooled from above, and the slight difference of temperature between the floor and ceiling of the vault is sufficient to dry completely the fingers and toes of the subject in the course of six months. This moisture, which leaves the floor of the vault, forms into large icicles about the steel pipes immediately below the ceiling of the room.

I have often been struck with the remarkable property of the epidermis to prevent the drying of the skin, even after it has been in a warm room for several months. This property can be increased to a very great extent by oiling the skin, a method we employ altogether to prevent our subjects from drying while the dissection is taking place. Vaselin is much superior to oil, and after many trials we use it exclusively to keep the skin soft and moist, both in the cold storage and in the dissecting room.

After the body has been embalmed it is smeared over with a large quantity of crude and cheap vaselin, and then wrapped with the continuous roll of water-closet paper. A second coating of vaselin in places over the paper covering the feet and hands and then the whole body is wrapped in muslin. This mummy-like body is now frozen and preserved in the cold storage. I have now kept subjects treated in this way for two years in the cold storage, and when placed upon the dissecting table they have all the appearance of fresh bodies. The wraps are not removed from the legs and arms until they are about to be dissected; they prevent the skin from drying before it is removed.

My experience, therefore, shows that subjects may be preserved perfectly and in the natural condition for years with carbolic acid, vaselin, and freezing.*

The Freezing Apparatus and Vault.—In applying cold storage in our laboratory it was necessary to adjust it to the heating apparatus of the building. The boilers for heating the building are 60 horse-power strong and are employed during the daytime of the winter only. It was necessary that they be high-pressure boilers, while the heating apparatus of the building requires low-pressure steam. If this could not be the case it would be necessary to add an additional boiler, calling for, in all probability, an additional fireman with additional expense for coal during the winter. This difficulty was overcome by the introduction of a reducing valve between the boilers and the heating system, which reduced the steam pressure to about one atmosphere for the heating, leaving high pressure in the boilers for the engine. The exhaust steam from the engine is allowed to escape into the heating apparatus, and thus performs an additional work in heating the building after it comes from the engine. An automatic pump forces the condensed steam back into the boilers.

The engineer is in the building during the daytime only, so we desired to construct our apparatus in such a manner as to accomplish the work for the whole twenty-four hours by operating the engine during the daytime only. If this were not the case it would cause a considerable extra expense to run the machine all night. This obstacle we overcame most successfully. In fact our ice machine and vault can do all the work we desire of it by working but a few days *per week*.

Then the apparatus must be relatively inexpensive. Before deciding upon the machine we purchased, we communicated with a number of firms, and believe that we have procured the cheapest as well as the best. Our machine and vault were constructed by the Remington Machine Company of Wilmington, Delaware, and cost considerably less than $4000. The cost of operating the machine in addition to our ordinary expense of heating the building has been less than $100 per year. The capacity of the vault is about 200 subjects, but can be enlarged sufficiently to supply all demands.

We purchased a two-ton machine, *i. e.* a machine whose refrigerating capacity in 24 hours is equivalent to 2 tons of ice; a photograph of it is shown in Fig. 3. This machine much more than fulfills our requirements, and may ultimately be used to cool a number of working rooms in the summer. Yet it is very desirable in the construction of any apparatus to have an excess of force at hand. Of the two systems employed for refrigerating a room we selected the indirect. In the direct method the compressed anhydrous ammonia is permitted to escape into coils of pipe suspended in the room through which the heat is absorbed. In the indirect method the coils of ammonia pipes are immersed in brine which is first cooled, and this cold brine is in turn pumped through a system of pipes suspended from the ceiling of the room (see Fig. 4).

In our apparatus the ammonia expands into a long coil immersed in 5 tons of strong calcium chloride solution, *B*. The operation of the engine, *E*, first cools this brine, which is now forced by an additional pump, *P*, through the pipes, *b*, along the ceiling of the vault, as the figure shows. The tank of calcium chloride brine is placed within the vault, and then when the machine is not running this great quantity of brine absorbs the heat which gradually enters through the insulated walls.

The vault is well constructed with a number of layers of boards, air spaces and mineral wool, as the diagram shows. Each layer of board is covered with one or two layers of paper; the outermost layer is tarred. The door is insulated in the same way and is over a foot thick. The interior is illuminated with electric light. There are thermometers on the outside which read the temperature of the brine as well as that of the air of the vault.

We found that in the beginning it was necessary to operate the machine for 36 hours continuously to reduce the temperature of the vault to 32° F. After this an additional run of the machine for 8 hours reduced the temperature of the vault to 20° F. During this time the brine was circulating constantly through the tubes suspended from the ceiling of the vault. The temperature of the brine at this time had fallen to 0° F., and we have never attempted to reduce it lower. With the vault at 20° F. and the brine at 0° the machine may

*The different methods employed in the various medical colleges in America for the preservation of anatomical material have been published recently by a committee appointed by the Association of American Anatomists, *Science*, Vol. 3, 1896.

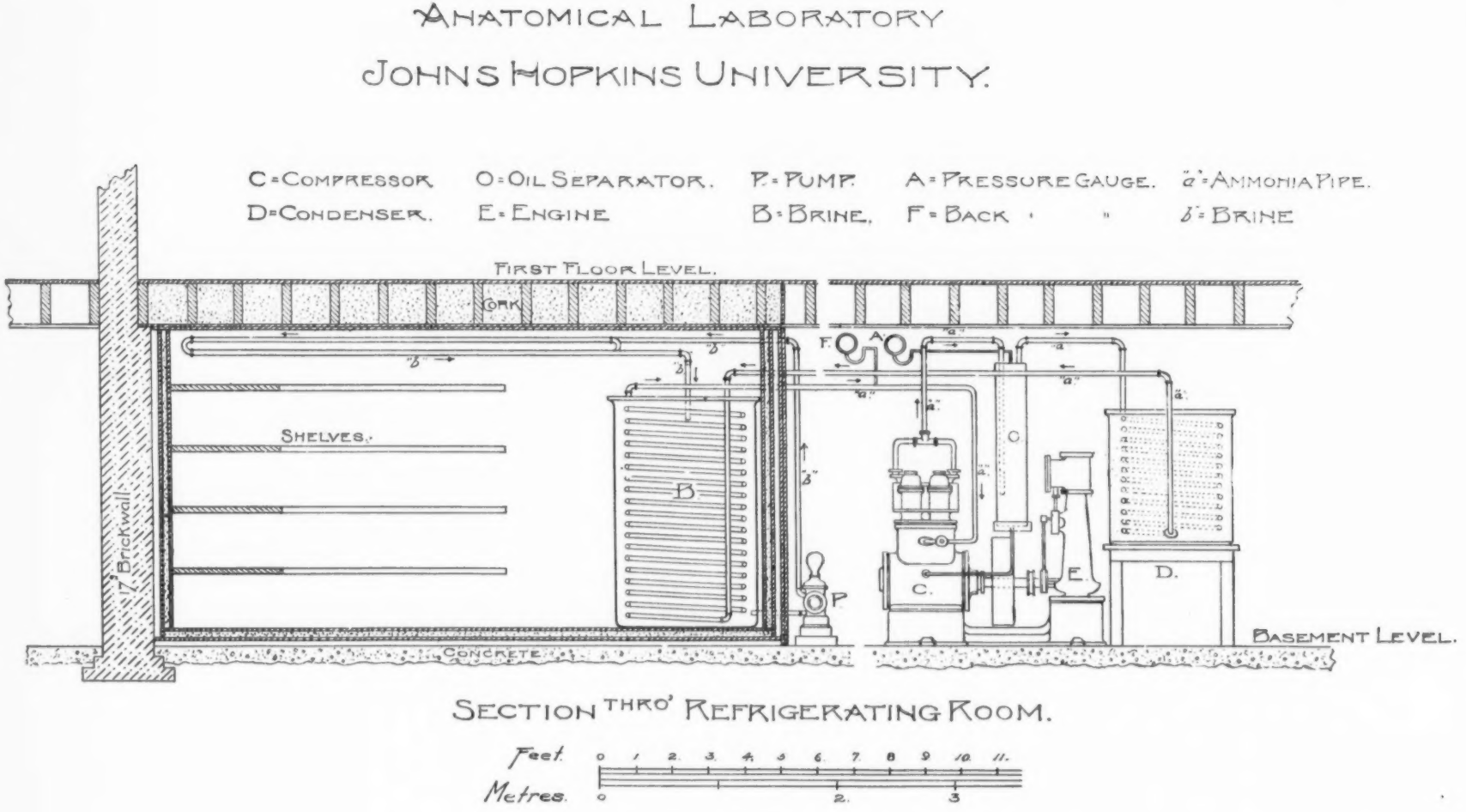


FIG. 4. PLAN OF COLD-STORAGE APPARATUS AND VAULT.

In addition to the insulation, as shown in the diagram, there is another two-inch air space covering all six sides of the vault.

remain quiet for a whole week, at the end of which the temperature in the vault is 32° and that of the brine 25°. When the temperature of the vault has risen to 32° it is desirable to cool it again, because opening the vault frequently causes thawing, thus making the room very sloppy.

Date.	Temperature in Degrees Fahrenheit.						
	Outside.		Brine.		Vault.		
1895.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	Duration of Run.
November 11....	59	69	..	..	29	25	8 hours
12....	59	62	..	..	29	25	2
13....	61	61	..	..	28	25	8
14....	62	73	11	0	26	21	8
15....	72	78	8	..	24	22	9
16 ...	71	78	6	5	24	20	4
17	..	..	..	..	..	..	0
18....	63	69	14	5	27	23	6½
19....	71	68	10	6	25	21	7
20....	70	73	10	2	26	21	8
21....	..	..	..	..	26	28	0
22....	60	..	..	..	29	..	0
23....	62	..	..	..	31	..	0
24....	..	..	..	..	..	..	0
25 ...	62	73	22	10	32	25	8
26....	72	78	13	2	28	23	8
27....	70	76	8	2	25	22	8
28....	..	..	..	..	..	..	0
29....	60	69	13	4	26	22	8
30....	70	76	9	0	24	21	6
December 1....	..	..	..	..	..	..	0
2 ...	64	76	12	0	26	21	7
3...	62	68	8	2	24	20	8
4....	56	57	..	..	27	26	0
5 ...	57	64	..	..	28	29	0
6....	56	62	..	..	29	30	0
7....	58	64	..	..	30	31	0
8....	..	..	..	..	..	..	0
9....	60	66	..	..	32	32	0
10....	58	67	25	8	32	23	8
11....	59	70	11	1	26	27	8
12....	60	64	..	..	28	29	0
13 ...	59	62	..	..	29	30	0
14....	58	62	..	..	30	31	0
15....	..	..	..	..	..	..	0
16....	49	48	..	..	32	32	0
17....	68	78	20	8	32	24	8
18....	70	78	8	2	29	20	8
19....	70	69	..	..	29	29	0
20....	68	68	..	..	30	31	0
21....	67	69	..	..	32	32	0
22....	..	..	..	..	..	..	..
23....	60	74	20	6	32	23	8
24....	72	78	11	2	27	21	10
25....	..	..	..	..	..	..	..
26...	76	74	8	2	27	20	10
27....	72	78	..	..	28	29	0
28....	74	78	..	..	30	31	0
29...	..	..	..	..	..	..	0
30 ...	68	..	18	..	32	..	8
31....	66	..	7	..	25	..	8
1896.							
January 1....	..	..	..	..	..	..	0
2....	68	72	..	..	28	29	0
3....	68	74	..	..	29	30	0
4 ...	64	68	..	..	30	31	0
5....	..	..	..	..	..	..	0
6....	58	60	..	..	32	32	0
7....	60	62	..	..	32	32	0
8....	64	67	20	8	32	25	8½
9....	68	72	11	2	27	20	10
10....	66	68	..	..	28	29	0
11....	68	70	..	..	29	30	0
12....	..	..	..	..	..	..	0
13....	61	68	..	..	31	32	0
14....	68	74	18	3	32	22	10

I have now taken the temperature of the vault, brine and outside room twice a day during a whole year, with the time the engine was running. The above table is a portion of this record.

The chart is not as complete as might be desired, for the brine temperature is not given for the time in which the machine is not running. This was not easily done, for it was necessary to start the engine to obtain the temperature of the brine. Our method of managing the apparatus is not to open the vault very much while the engine is not running. When the vault is opened frequently during the day its temperature rises rapidly and necessitates starting the machine. The temperature records of December 2d and 3d are accounted for by the frequent opening of the vault.

After we are accustomed to a cold-storage plant for the preservation of anatomical material it is difficult to understand how we ever got along without it, as difficult as it is to get along without a microtome. It makes us commander of the situation for all times of the year.

In our anatomical course we employ extensively pigs' hearts and lungs, sheeps' heads and other material obtained from the slaughter-house. These materials are frozen and kept on hand constantly. The same applies to preservation of dissections during the holidays when students cannot attend to them. More important than either of these is the preservation of large dissections used in teaching. It dispenses wholly with the large alcohol vats. The large dissections are wrapped in vaselined cloths and simply labeled. It is as easy to manage such dissections as it is to care for a large model. Furthermore, the vault may be considered a large freezing microtome for cutting cadavers, or even for cutting serial sections on an ordinary microtome. And last, but not least, we preserve cadavers not suitable for dissection, as well as carcasses of animals until we are prepared to make skeletons of them.

Before we decided to adopt cold storage we obtained many valuable hints from Professor Huntington of Columbia College, New York, who had employed a machine similar to ours for a greater length of time. I am under many obligations to him for valuable recommendations. Yet our apparatus can be improved in a number of ways, the most important of which I believe to be the construction of two vaults, one within the other; the inner vault to be surrounded completely with the cold brine and to be used for freezing the bodies; the other vault to be used for preserving purposes, and to be kept at 32° F. or slightly below. In this case the engine could be used to cool the brine about the inner vault whenever necessary. Moreover, the outer vault should be surrounded with a brick or stone wall, as the expansion and shrinkage of wood are too great. This expansion is very marked and causes destruction of the insulation, and finally of the whole vault. I should also cover the floor with zinc or some metal and have it drained. It is necessary to clean the vault about once a year, and the extensive thawing is very injurious to the floor.

Ground Floor.—The first floor is occupied temporarily by the Pharmacological Department. It contains a large room ultimately intended for microscopical work, but at present used as a lecture room. There is also a combustion room, a library, a chemical laboratory, an experimental room, and a private

room. Through the kindness of Professor Abel the experimental room is used by the advanced workers in anatomy. It is fitted up with the necessary apparatus for registering blood pressure, for artificial respiration, and so on. The motor-power is obtained from the engine in the basement.

Histological Laboratory.—The histological laboratory is constructed with light on three sides in order to have the maximum working space. The main side faces north (Fig. 6). In all there are 15 windows in the room, giving window space for 30 students. The east end of the room is shown in Fig. 7.

room, which is practically the interior of a microscope, and are shown what they are expected to study.

It is the aim of this course to illustrate the general anatomy, as is often the case in systematic lectures, with demonstrations and specimens. During the first half of the course fresh specimens are studied almost altogether, and throughout the course frozen sections are given the class with each organ.

We have a great abundance of pigs' embryos, which can be obtained by the hundred every day. These are used a great deal in studying the histogenesis of the organs.

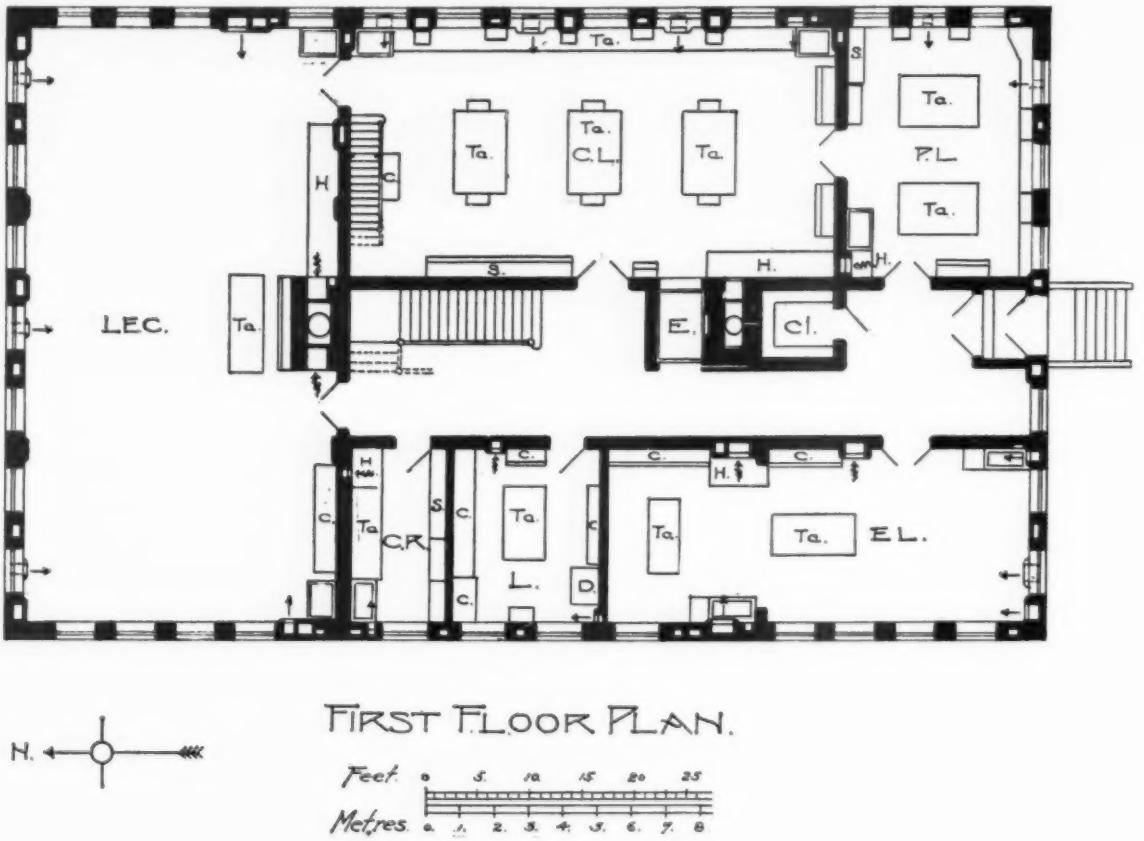


FIG. 5.

LEC, Lecture room. *CL*, Chemical laboratory. *PL*, Private laboratory. *EL*, Experimental laboratory. *L*, Library. *CR*, combustion room. *Cl*, Closet. *H*, Hood. *C*, Cases. *Ta*, Tables. *S*, Shelves. *D*, Desk. *E*, Elevator.

The full capacity of the room is 50 or 60, the additional students to be placed in the middle of the room. Each student is furnished with the necessary outfit and a Leitz microscope, Stand II, with Abbe condenser. Students are permitted to take the microscope from the building, as each one is personally responsible for everything placed in his charge. Each student has also a dissecting microscope.

The lectures are given in the laboratory with necessary charts, models, and gross as well as microscopic specimens to elucidate the subject. Whenever necessary, as in the case of the medulla oblongata, they are all taken into the photographic

In addition to the systematic course given there is an optional course in technique. The class is divided into groups of ten, and each group takes up a class of tissues like the alimentary canal, and so on. The course is not the same from year to year, and this variation proves to be most instructive to the students. They enter the course with enthusiasm and profit a great deal by it. They aid materially also in the preparation of the specimens for the class. Although this course is optional, practically all the students take it.

Throughout the course students are encouraged to read a few special monographs. They soon grow beyond the text-

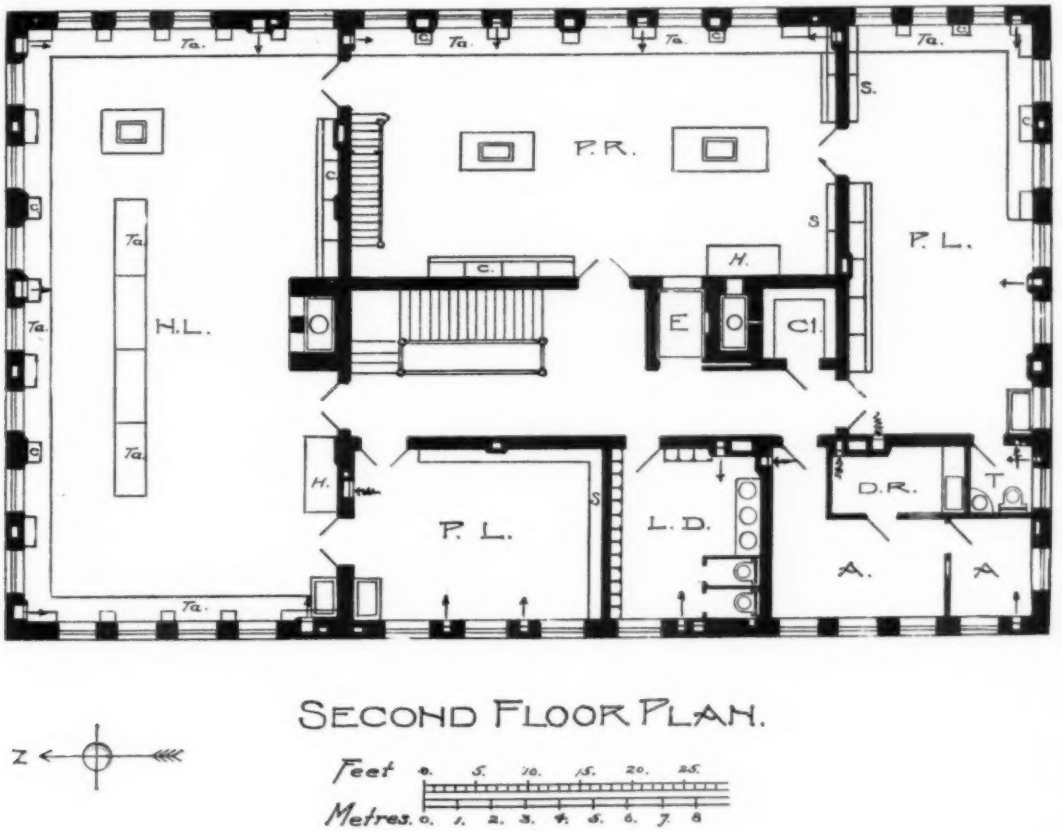
FIG. 7. HISTOLOGICAL LABORATORY ON THE SECOND FLOOR

FIG. 8. SOUTH END OF THE PREPARATION ROOM ON THE SECOND FLOOR.

The apparatus and reagents which are used in common for all kinds of histological preparation are in this room.

books, and by this reading gain a much better idea of the scope of histology. We find that with the research method of teaching we can lead the student much further into the subject than without it. Students do better work when you expect much of them than when you expect little.*

Preparation Room.—The preparation room is located conveniently about the center of the building, and is used for all the work of the advanced students, and for the preparation of the specimens for the histological course (Fig. 6, *PR*, Fig. 8). It is fitted up with the necessary apparatus for the work



SECOND FLOOR PLAN.

FIG. 6.

HL, Histological laboratory. *PR*, Preparation room. *PL*, Private laboratory. *DR*, Dark room. *A*, Light room. *A'*, Projecting room. *LD*, Women's dressing room. *T*, Toilet. *H*, Hood. *C*, Cases. *S*, Shelves. *Ta*, Table. *E*, Elevator. *Cl*, Closet.

—a set of Grübler's stains† and other reagents; ordinary microtomes of Thoma‡ and Schanze;§ the Minot microtome by Zimmermann,‖ and the CO_2 freezing microtome of Bausch and Lomb.¶ In addition to the large injecting apparatus in the embalming room, this room contains the apparatus of Ludwig for fine injections made by Petzold.* The hood, arranged with hot and cold water and well ventilated, is intended primarily for the making of corrosion specimens; it also contains the automatic water still by Stoelting.† There is also an incubator and a large paraffin oven, both made by Keen & Hagerty.‡ The glassware of this room as well as all the jars of the building are after the same pattern, and have been made by Jahneke & Hofmann.§ The jars are all ground flat on top, and are either fitted with flat lids with a knob or, as in the case of the large jars, with ground plate glass. Along the wall there are a number of lockers for advanced students' microscopes, etc.

In the center of the room are two large preparation tables, drained to a central sink, with hot and cold water and gas. These are extremely useful for all kind of work, from boil-

* The details of this course are given by Barker and Bardeen, Johns Hopkins Hospital Bulletin, Baltimore, No. 62.

† Dr. G. Grübler & Co., Bayerische Str. 63, Leipzig, Germany.

‡ R. Jung, Landhaus Str. 12, Heidelberg, Germany.

§ M. Schanze, Bruder Str. 63, Leipzig, Germany.

‖ E. Zimmermann, Emilien Str. 21, Leipzig, Germany.

¶ Bausch & Lomb Optical Co., Rochester, New York.

* N. Petzold, Bayerische Str. 13, Leipzig, Germany.

† C. H. Stoelting Mfg. Co., 128 South Clinton St., Chicago, Ill.

‡ Keen & Hagerty, Baltimore, Md.

§ Jahneke & Hofmann, Frauenwald in Thür., Germany.

ing of reagents, or making wax plates, to distilling alcohol. This room is among the most active in the building, and takes the place among the advanced students which the dissecting room does among the beginners. It is the general shop of the laboratory.

While there has been a great agitation in Europe for a *Studienzimmer*, I believe that the great need is just such a room as I have described for advanced students. We have also a study room, but it loses much of its force, because all the dissecting rooms are study rooms. Yet we have one room where the student can make shorter dissections and study preparations.

Photography.—Optical apparatus in connection with photography is such an essential to morphological research that before our laboratory was designed we purchased the large Zeiss outfit, with modifications similar to those I have had made for the University of Chicago four years ago. This apparatus had designed for it rooms as shown in Fig. 6, *A*, the idea being to enter the "camera" for all kinds of work.

We have, however, made a number of alterations in the electric light as well as in the screen for the reception of the picture projected. Dr. Hoen has had adjusted to the Zeiss apparatus a lamp of 4000 candle power, for alternating current, which is most satisfactory in every respect.* We have a set of lenses which enables us to enlarge any picture from one diameter to two thousand, and a movable screen aids us to obtain a given number of diameters easily, which is necessary for reconstruction work.

Our photographic lenses have been made by Zeiss, and they are interchangeable from the ordinary camera to the Zeiss camera, as well as to the lens holder on the large Zeiss projecting apparatus. This last arrangement enables us to use these lenses for the projection of histological sections as well as for lantern slides.

This room is perfectly dark, thus permitting us to expose a negative or a bromide by simply attaching it to a screen as described by His.† The screen we employ is movable and very simple in its construction. It is more fully described by Dr. Hoen. By opening the blinds daylight is admitted into both projecting and developing rooms. We thus have complete command of the light, enabling us to use the rooms for a variety of purposes.

Private Rooms.—The rooms marked *P*, *L*, and *A*, on the second floor, as well as three rooms on the south side of the third floor. are used as private rooms for advanced students at present. The arrangement of one of these is shown in Fig. 9. The fact that the furniture and cases are only loosely attached to the rooms enables us to rearrange the whole laboratory from time to time as circumstances demand.

Dissecting Rooms.—The traditional large dissecting room has been abandoned altogether. As a substitute for it we have nine small rooms, the largest one to hold eight or ten dissecting tables, while the smallest room holds but one table. The upper floor was at first constructed as two large and two small rooms, and after the building was finished the additional rooms were made by inserting thin partition walls, as shown in Fig. 10. This arrangement facilitates enlarging the rooms at any time if necessary.

The criticism has frequently been made that it is difficult to discipline the students if an instructor is not always present. Our experience proves that this is not the case, as the students remain quiet and orderly without the presence of the instructor. They know that their only opportunity of learning anatomy is in the dissecting room, and generally utilize it. The universal opinion of the students is in favor of small rooms, and most of them prefer the rooms with but one table. The same order is insisted upon for the dissecting room as for the lecture room, and all are agreed that it is for the best. I allow the students to arrange their own dissecting classes, and always favor the good students by placing them in a room by themselves whenever possible. No smoking or loafing is permitted, and this again favors the work of the student.

Each room is fitted up with tables, chairs, book racks, hot and cold water, a sink, model cases, and a blackboard. In fact each is a study room by itself. Fig. 11 shows a corner of one of the smaller rooms. The floors are of Georgia pine, and are saturated with paraffin once a week, and are usually kept very clean. As soon as they become slightly soiled they are scrubbed with lye and saturated with paraffin again. Each room has a skylight, which, with the addition of the great number of windows, gives a most excellent light in all parts of the room.

The subjects come into the room vaselined and wrapped as described. The extremities are kept wrapped with the vaseline until the skin is removed, and when the body is cut the muscles are kept from drying by means of moist, but not wet, cloths. An excessive moisture favors decomposition and also soils the floor.

The course in practical anatomy begins immediately after the completion of the brief course on osteology. At the beginning of the session each student is loaned a skeleton for the year and also assigned a place in the histological laboratory. The latter entitles him to an outfit and the use of a Leitz microscope, Stand II, with an Abbe condenser, eyepieces I and III and objectives 3 and 7. During the second year a $\frac{1}{12}$ oil immersion is added to the microscope. He thus has the use of a good microscope throughout his student time at this University.

During October the beginners are requested to arrange themselves into groups of twos or fours to aid the instructor in making up the dissecting classes. The first subjects are dissected by six students, the two on the head being second year students and working on alternate forenoons. The beginners start on the abdomen and chest. The weekly task placed before each student during the winter is about as follows. It must be remembered, however, that after the dissection is fairly well started each student works for himself and by himself.

In the following chart Class No. III is composed wholly of second-year students. First-year students, who begin with Class No. I, usually dissect the whole body in 22 to 26 weeks.

*Hoen, The Photographic Room of the Anatom. Lab., Johns Hopkins Hospital Bulletin, Nos. 62–63.

†His, Mikrophotographisches Apparat. d. Leipziger Anatomie, Leipzig, 1892.

FIG. 9. A PRIVATE LABORATORY ON THE SECOND FLOOR.

FIG. 11. INSIDE VIEW OF ONE OF THE DISSECTING ROOMS ON THE THIRD FLOOR.

APPROXIMATE ARRANGEMENT OF THE COURSES IN GROSS ANATOMY AND IN HISTOLOGY.

Week.	20 to 30 Hours per Week.			15 Hours per Week.	Week.
	Osteology.			Histology.	
1	Spinal column			Vegetable cell and fibers	1
2	Upper extremity			Animal cells, egg and germ layers.	2
3	Lower extremity				3
4	Head			Cartilage and muscle	4
5	Head			Neuron	5
6	Head			Blood	6
	Class I.	Class II.	Class III.		
7	Abdominal walls	Chest walls	Superficial neck	Blood-vessels, lymph and lymphatics	7
8	" viscera	Axilla	Deep neck	Bone	8
9	" "	"	Face	Connective tissue fibrils	9
10	Lumbar plexus and thigh	Front of arm	Sympathetics and heart	Muscle	10
11	Back and gluteal region	Back	Back of neck.	Alimentary canal	11
	Body divided.		Arm removed.		
12	Perineum (*pelvis cut*)	Back of arm	Temporal and frontal region	Alimentary canal	12
13	Thigh	Remove muscles	Muscles of mastication & nerves	" "	13
14	Leg and foot	Class I.	Tongue and larynx	Urinary organs	14
15	Remove muscles		Base of skull	Reproductive organs	15
16	Class II.		Eye	Skin and nose	16
17			Class I or II, or Special Dissection.	Eye and ear	17
18				Spinal cord	18
19				Medulla oblongata	19
20				Medulla oblongata	20
21				Brain	21
22				Brain	22

About one-half of the first-year students do not dissect the head until the second year.

All of the students have had one year each of physics, chemistry and biology before coming to us. Most of them have had a course in practical embryology. The course in embryology at this University is given during the spring of the year.

John Hunter has expressed himself that the only way to learn anatomy was by dissection and dissection and dissection. We believe firmly in this method and add to it *concentration*. If any one desires to know the very essence of an investigator's spirit let him read the introduction of v. Bear's Embryology.* The feelings of a scholar are expressed on every page. His association with his instructors meant so very much to him. Later, in his autobiography,† he rehearses the early period of his life and says: "Often during my life then,‡ as well as later,§ have I doubted the wisdom of our university courses. It seemed to me that the whole system was wrong in that it compels us to take a number of courses for 45 minutes at a time in order to convert our information into a heterogeneous mass. Would it not be better if we could study one subject after the other, so that we could busy ourselves with one, or at the highest two, subjects continuously for several weeks?" He continues this thought further, and finally states that whenever we wish to do anything thoroughly we do one thing at a time.

As a student I demanded the privilege of studying one subject at a time and was often envied by my fellow-students. The privilege I then demanded I now gladly give my students and am extremely well gratified with the result. Continuous individual instruction is not easy and takes much time, yet I believe that I can carry the plan through with a much greater number of students than I now have.

At present we devote 22 continuous weeks to gross anatomy and histology exclusively during the first year, and about the same time to the dissecting room during the second year. In later years the students may continue to dissect, and if they are especially desirous of studying a number of parts at the same time they are employed as student demonstrators.

Our dissecting room is open every day from Monday morning until Saturday evening, and with a class of 70 we have an average attendance of 30 students during all this time.

Each student keeps a complete record of all the nerves he dissects, and when he has finished the parts he is examined on what he has dissected before the muscles are removed. I keep on file a card for each dissection which ultimately receives all the notes the instructors have made of the quality of his work. This gives us a permanent record of all the work which is done by the student in our laboratory.

With all this precaution we still have poor students. First and foremost we are careful to admit only those students who have had a good training,* and then when they come to us

* v. Bear, Entwicklungsgeschichte der Thiere, Königsberg, 1828.

† v. Bear, Nachrichten über Leben und Schriften, St. Petersburg, 1866.

‡ 1815.

§ 1866.

* From the Announcement of the Johns Hopkins Medical School, for 1895–96:

As candidates for the degree of Doctor of Medicine the school receives:

1. Those who have satisfactorily completed the Chemical-Biological course which leads to the A. B. degree in this university.

2. Graduates of approved colleges or scientific schools who can furnish evidence: (*a*) That they have a good reading knowledge of French and German; (*b*) That they have such knowledge of

we give them an opportunity to work. Some, however, are not bright, and a few others are not inclined to work. They, of course, do not accomplish much, and I should feel inclined to hold our method of instructing them in anatomy responsible for it were it not that they do equally poor work in other departments where the lecture method is employed.

Study Room.—In recent years there has been an agitation in favor of teaching anatomy by means of a study room. This method is practiced in many universities by placing the objects used to illustrate a lecture at the disposal of the student after the hour; he can then take the specimen in his hand and see for himself. A few students utilize this opportunity, but it is only of much value to advanced students.

If now all these specimens and models are placed together in one room which is at the disposal of the student, we have the study room as arranged by Rauber* in the University of Dorpat, or by Kollmann† in the University of Bâle. Similar methods of instruction are employed in the Austrian universities, and I have observed their use in Professor Toldt's laboratory in Vienna. Professor Drasch of Graz also informs me that they were used extensively while he was a student. We are all familiar with the excellent exhibitions of anatomical specimens in the English laboratories and museums and appreciate fully their importance as recently emphasized by Prof. Keiller.*

A whole series of papers has been written during the last 20 years about the teaching of anatomy, and the universal opinion is in favor of teaching and studying at the same time;† to study the object from every standpoint. There has been a marked revulsion against simply giving the students the *results* of anatomy—the favorite method in America today. The references just given will be very instructive to the advanced students of anatomy and I recommend that they be read freely.

In the early part of this century Rudolphi‡ wrote an essay on the various methods of learning anatomy and gives an extensive literature on the subject. "Yet," he says, "it is wholly indispensable for those who wish to study anatomy to make their own dissections, for the best preparations made by others, the best plates, etc., cannot take the place of specimens made by the students. It is altogether a different thing to have dissected the vessels and nerves for one's self and to have observed their relations, than to have simply seen the finished preparation in which the parts are more or less distorted." In this way Rudolphi continues in the most interesting manner.

In our laboratory we have set aside a large room as a study room, but find that there is no special demand for it as long as the students can make their own dissections. As soon as they have begun work it is easy to make them find most of the fine nerves as well as the sympathetics, and after the part is fully dissected it is taken to pieces systematically (and this is the review); then the ligaments are studied. We have made a study room of all of our dissecting rooms, and our *Studienzimmer* remains as a room for special and briefer dissections. It is fitted up with coarse vises for holding sheeps' heads and useful things of that kind. When students desire to study the peritoneal cavity of a lower animal, to dissect or macerate hearts, or to dissect sheeps' eyes, this room is used. Here they also study finished dissections and models which are at all times at their disposal. Throughout the dissecting rooms there are large cases in which are exposed many of the models and preparations of Ziegler,§ Steger,‖ Benninghoven

physics, chemistry, and biology as is imparted by the regular minor courses given in these subjects in this university.

The phrase "a minor course," as employed in this university, means a course that requires a year for its completion. In physics, four class-room exercises and three hours a week in the laboratory; in chemistry and biology four class-room exercises and five hours a week in the laboratory in each subject are required.

Many inquiries have been received regarding the character and amount of the requisite training indicated by the term "Minor Course" in these sciences. In explanation, it may be stated, with respect to Biology, that the candidate should have followed for at least a year a laboratory course in the structure, life history, and vital activities of selected types of animal and vegetable life. In the Chemical-Biological course for undergraduates in this university the laboratory work in biology at present includes the study of such types as amœba, hæmatococcus, yeast, penicillium, bacteria, mushroom, hydra, vorticella, a fern, a flowering plant, the earthworm, lobster, anodon; the gross and minute anatomy of the frog, the development of its eggs, the structure, formation, and metamorphoses of the tadpole; the study and drawing of the bones of the human skeleton; the comparison of some parts of related vertebrate skeletons; dissection of a mammal; the field and laboratory study of some few flowering plants. The laboratory work is the more important part, the lectures and other exercises subsidiary. It is, of course, not to be understood that this curriculum of biological work must be rigidly followed. Equivalent work will be accepted.

The candidate should have followed a course in general Chemistry for at least a year. This course should include laboratory work, about five hours a week through the year, and lectures and class-room work covering the outlines of inorganic chemistry and the elements of organic chemistry. A good knowledge of the subject as presented in Remsen's "Introduction to the Study of Chemistry" may be regarded as the minimum requirement. A fuller knowledge of Chemistry is, of course, desirable.

In Physics, the candidate should have followed a collegiate course for at least one year. This should include four hours a week of class-room work and at least three hours a week of quantitative work in the laboratory. Special attention should be given to theoretical mechanics and to the mechanical and electrical experiments.

3. Those who give evidence by examination that they possess the general education implied by a degree in arts or in science from an approved college or scientific school, and the knowledge of French, German, physics, chemistry, and biology above indicated.

* Rauber, Entwicklung von Studiensäle, Leipzig, 1895.

† Kollmann, Archives des sciences physiques et naturelles, t. 28, 1892, and Verhandl. d. anatom. Gesellschaft, 1895.

* Keiller, New York Medical Journal, 1894.

† His, Auffassung der organischen Natur, Leipzig, 1870; His, Aufgabe u. Zielpunkte der Wiss. Anat., Leipzig, 1872; Turner, Address at the Opening of the new Anatomical Department at the University of Edinburgh, 1880; Hertwig, Der anatomische Unterricht, Jena, 1881; Schiefferdecker, Der Anatomische Unterricht, Deutsche Med. Wochenschrift, 1882; Kolliker, Die Aufgaben der Anatom. Institute, Würzburg, 1884; Waldeyer, Wie soll Man Anatomie lehren und lehrnen, Berlin, 1884.

‡ Rudolphi, Ueber Anatomie, Berlin, 1828.

§ Ziegler, Freiburg in Baden, Germany.

‖ Steger, Thalstr. 26, Leipzig, Germany.

FIG. 12. NORTHWEST CORNER OF THE STUDY ROOM ON THE THIRD FLOOR.

The case shown contains the wax models made by Ziegler. The main part of the room is devoted to the study of models and finished dissections.

and Messing,* Auzoux,† Tramond,‡ as well as the wire models of Abbe and Edinger.

The finer preparations of bones are employed to elucidate the course in osteology, and there is an abundance of loose bones at the disposal of the instructors. In addition to excellent mounted skeletons we have complete skeletons, which are loaned to the students for the whole year. If there is any breakage or loss of bones the student must pay for a new skeleton. The method of placing good-specimens and instruments at the disposal of students works admirably when the responsibility of keeping them in good order rests upon the student. Whenever the student wishes to study the attachment of muscles or anything of that kind, a mounted skeleton is placed at his disposal in the study room.

The plan of the third floor shows the arrangement of the women are in a special room on the second floor. This room is also fitted up with a table, a few chairs, washstands with hot and cold water, and closets. The closets for the men are in the basement and the third floor, while in addition to these there is a private closet for each floor.

Store-rooms.—One of the most important adjuncts to a laboratory is an abundance of store room. There is on each floor a large hall room for the use of the janitor's utensils, laundry, and so on; each is well ventilated. In addition to the cold storage we have two rooms in the basement in which to keep alcohol specimens during the summer and at other times when they are not in use. The whole fourth floor is one large store room communicating with the elevator (Fig. 13). A glance at the plan will show the arrangement. The central hall is illuminated by all the skylights of the building, thus

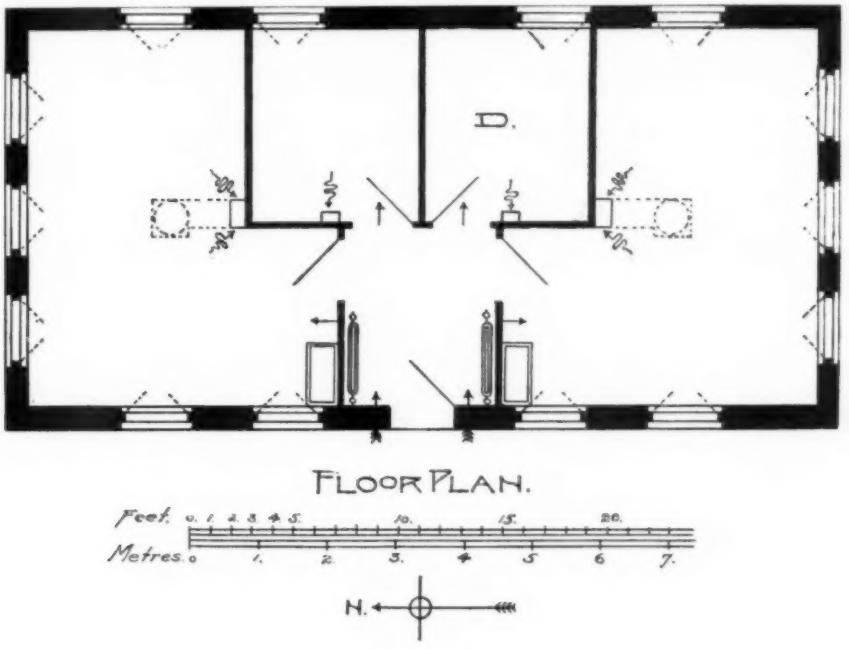


FIG. 14. THE ANIMAL HOUSE.

model and specimen cases. The models are well displayed and can be taken out easily to demonstrate any point as it may arise.

Lockers.—There are a number of hat and cloak hooks in the halls of the first and second floors, where students can lay off their wraps easily before going into the histological laboratory or the lecture room. On the third floor there are a number of lockers for men, with latches, but the padlocks must be supplied by the students if they desire to lock them. In the autumn the lockers are assigned to the students, who may retain them for one complete year, thus giving them a place to lock up their things during the summer. The lockers for the

making it a very agreeable room to work in. In addition to this there are twelve large store rooms used for all kinds of bulky ware necessary in an anatomical laboratory. Special rooms are set aside for glassware and others for chemicals. As we still import most of our equipment, it is necessary to lay in a stock for the whole year and to have an abundance of storing space. The alcohol and other very inflammable substances are stored in an underground vault outside of the building, which communicates with the basement. This enables us to procure a sufficient supply, duty-free, to last for a year. Under no conditions could we keep a large quantity of inflammable material on hand without such a vault, for it would be impossible to place an insurance upon the building.

Animal House.—One of the most difficult problems in the construction of a laboratory is the care of live animals. A

* Benninghoven and Messing, Dorotheenstr. 38, Berlin, Germany.
† Auzoux, Rue de Vaugiard 56, Paris, France.
‡ Tramond, Rue de l'Ecole de Médecine 9, Paris, France.

number of methods are employed, and it matters little whether the animals are kept in the basement or the attic, they are a nuisance and hard to care for. When either of the above arrangements is made it is impossible to make any alterations in the room from time to time as circumstances demand. The simplest and easiest method is to construct a special animal house. Our animal house is completely separated from the building, and has its own yard in which the animals can run about. The house (as Fig. 14 shows) is divided into four rooms, each of which is ventilated by itself. There are hot and cold water in the large rooms, and all the floors are asphalted and drained. The rooms are heated by steam from the boilers in the main building. In addition one of the rooms has a large coal stove for heat during the night in cold weather. We can thus give animals every comfort and cleanliness, and find that under these conditions dogs are not very noisy. The house is practically a hospital for operated animals, monkeys as well as dogs.

A space has been set aside in the basement for aquaria, but they are yet to be constructed.

Macerating Rooms.—A large room on the fourth floor is fitted up especially as a macerating room. It has a special ventilating flue, a store room adjoining for clean bones, and a large balcony for bleaching and drying purposes (Fig. 13, *BB*). The room has hot and cold water as well as a special steam connection with the boilers in the basement. The skeletons which come from the dissecting rooms are placed in sacks and numbered, which in nearly all cases completes the record of each subject. The bones from the subjects embalmed with carbolic acid are cleaned with lime or 1 per cent acetic acid. In either case we must boil them; and this is easily done with steam. In addition to these skeletons we obtain subjects too far advanced in decomposition to embalm, and they are first frozen and then cleaned as soon as time will permit, often a year after the subject is obtained. All of the bones cleaned are preserved until summer, when the fat is extracted from them. Our extractor was made by Lentz,* and it is set up in the animal house for additional security in a room containing the alcohol stills. The water-bath of the apparatus is heated with live steam, which is easily controlled and is more satisfactory as well as safer than the gas flame. The apparatus can be started and may run for days without any special attention.

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AN OUTLINE OF THE COURSE IN NORMAL HISTOLOGY AND MICROSCOPIC ANATOMY.

By Lewellys F. Barker, M. B., and Charles R. Bardeen.

The problem of reducing to a minimum the amount of energy expended in the routine work of teaching is one which necessarily interests every working histologist. While we would deprecate the adoption of a fixed, rigid programme to be followed year after year, we believe that in a subject like normal histology, where many of the methods employed are constant, a careful list of the work actually done and of the methods actually used during one or two years will be of considerable service as a basis for the organization of the course in ensuing years. The programme which we present here is almost exactly that which has been followed during the past year in the Johns Hopkins Medical School. It is by no means intended to represent an ideal course in histology; on the contrary, it has very obvious defects, some of which we hope soon to be able to remove. It is simply a course which has been given, adapted to certain conditions, and one to be modified from time to time with changing conditions and as further experience of our own and others shall indicate.

In framing a course in histology for the regular students of this school there were certain points which demanded particular consideration. In the first place, the class of students might fairly be expected to differ from that of the average medical school. Every student, in order to gain admission, must have a college degree or its equivalent, must possess a good reading knowledge of French and German, and in addition give evidence of having studied biology, chemistry and physics, including practical laboratory work in these subjects during at least one year. It might be safely assumed that the average student in such a school, as a result of his previous scientific training and experience, would be able to do more and better work in normal histology and microscopic anatomy, than has before been expected of medical students, and our experience thus far justifies such an assumption. One difficulty which speedily became obvious, however, was the unequal preparation of the different students for microscopic study on entering the school. Whereas some of the students had worked extensively with the microscope, an occasional one having had more than a year's instruction in practical histology, others in their work in practical biology had done little normal histology or none at all. In organizing a course, the needs of all the students had to be considered, and arrangements were made by means of which the experienced found work difficult enough for them, and the untrained were given tasks which were not beyond them. It is probable that this inequality as regards preliminary attainments in microscopic work will grow less with the years, since the students admitted at the beginning of the school have had no opportunity of directing their preliminary education to suit the requirements of admission. But there must always be greater individual differences, probably, among the class of students entering such a school, than in the medical school requiring no college degree before admission, inasmuch as, other things being equal, specialization and individuality increase *pari passu* with age and educational advantages.

In deciding as to the plan to be adopted in the course we have been much influenced, too, by the fact that our students are students of medicine. Thus it will be noticed that in the selection of tissues, those from the human body make up a large part of the material used; and when animal tissues are employed, special care has been taken to point out how they

differ from the human. Moreover, in deciding what to exclude from the course—for this we think as important as the matter included—thought was given to the bearing of the specimens on the practical work in medicine which was to follow, and stress was laid upon those portions of human histology which previous experience has taught us are of the most importance in the appreciation and interpretation of the pathological alterations in disease. While in the future all detail will, we must believe, be found to be of importance to the pathologist, in the present status of pathological histology a knowledge of certain details is of much greater value than that of others; and for the student entering medicine, a judicious selection of what shall be given and what shall be left out should be made by some one who has had a more or less wide training in pathological histology.

The time is now past, we believe, when an instructor in pathology should be compelled to devote the time intended for the study of diseased tissues to instruction in normal histology and microscopic anatomy. It is true that every student has his knowledge of normal structures widened and more firmly rooted by good courses in pathological histology, but he should not meet with normal appearances in these courses for the first time.

Further bearing in mind the life-work for which the student is preparing himself, we have not, in this course, always chosen the method which would show the finest structural details of the tissues. While the most delicate methods have been introduced in places, we have endeavored to familiarize the students with a large number of different modes of preparation, and to help them to understand the varying appearances of one and the same tissue under different methods of preliminary treatment. A piece of spleen hardened in Müller's fluid is quite unlike a portion of the same organ hardened in alcohol or in Flemming's mixture, and the appearances of such tissue in stained section differ still more from those to be seen in a frozen section of the fresh spleen. The student who has been brought up entirely on "gilt-edged" histological methods will find himself sadly at a loss in battling with the "rough and ready" world in which the pathologist has to live.

Nor could we leave out of account, in framing the course, the fact that in the studies of the subsequent three years, various portions of the body are again submitted to extended microscopic investigation. Thus in the second year in the department of pathology, a preponderance of attention is paid to the structure of certain of the organs; in the third year in the department of medicine, the blood of patients is submitted to very accurate color-analyses, and in the course in obstetrics the histology of the female genital organs is again thoroughly reviewed. In surgical pathology, microscopic work is also done, and in the planning of the courses in neurology, dermatology, gynæcology, ophthalmology, etc., provision will doubtless be made for microscopic work.

The course beginning October first extends to March fifteenth. Three *full* half-days are devoted to regular class work, and additional time throughout the week is available for special work in technique, recitations and drawing. Between March fifteenth and June first considerable time is available for review, and for extra work for those students who have had difficulty in keeping pace with the course while in progress.

The teaching, consisting in the main of practical work in the laboratory under the direct guidance of a corps of demonstrators, is supplemented by a series of 60 lectures with demonstrations, explanations of charts and models and dark-room projections.

After some introductory work on the cell in general, and a review of the blastodermic layers, the student begins his histology with the study of the morphological units in the body, that is to say, with the study of general histology, and proceeds to the study of the architecture of the organs (microscopic anatomy) only after he has had considerable experience in isolation and dissociation by means of teasing, tearing, dissecting, macerating, corroding and digesting the elementary tissues. It has seemed to us that this system has marked advantages over that in which histological studies are begun with the study of organs. The student who tries to study organs when he cannot recognize almost at a glance epithelium, smooth muscle, striped muscle, cartilage cells, nerve cells, nerve fibres and the like, is comparable to the student in chemistry who attempts to understand and memorize the reactions of complex organic compounds without having been taught the significance of an alcohol-, an aldehyde-, an amine- or amide-group. Familiarity with units is, we are convinced, the only key to a proper understanding of the tissues. And thus in the study of organs the student is stimulated to search for morphological units of a higher order—for example, vascular or secretory units—a task which can often be lightened by the study of developing tissues where such units may generally be seen in simpler forms.

From the first the student is advised to pass as gradually as possible from the naked eye appearances to the relations as seen under high powers of the microscope. Thus after the naked eye study in the course, and the color, odor, consistence, etc., have been noted, pieces of the tissue are examined with the aid of the dissecting microscope (8-20 diameters), first in bulk and afterwards dissociated; only then does the examination with higher powers of the microscope begin, at first with low powers and finally with high powers, in some instances with oil-immersion lenses.

During the early part of the course very few microtome sections are permitted, and, throughout, the importance of methods other than those of mere sectioning is especially emphasized. The student goes to the animal body or to the cadaver in the dissecting room, sees the general relations of the tissues there, procures for himself the specimen, and thus is taught how and where material for study is to be obtained.

In addition to the regular class work, to each student is assigned the task of the complete preparation of some tissue or set of tissues, involving the processes of fixing, hardening, embedding (in celloidin and paraffin) and sectioning. Some members of the class find the time to do more of this sort of work than others, and as all of it is done under the direct supervision of an instructor, the technical experience gained should be subsequently helpful.

It will be noted in the tables that liberal use has been made

of embryonic tissues. Starting out with the blastodermic layers, the student from the first is taught to lead all tissues, as far as possible, back to their early embryonic origin, and through the whole course no small measure of the attention of the student is directed to the histogenetic relations, at different stages, of the tissue or organ under consideration.

While the morphological facts are necessarily the first objects in the course, still the physiological bearings are not entirely lost sight of, and we have had no hesitancy now and then in calling the attention of the students to a physiological, chemical, or even clinical relation when we have thought it important that it should be especially associated in the mind with a certain morphological peculiarity. Thus, while any marked "overlapping" of courses is avoided, the attempt is made to impress upon the student the fact that histology, instead of being divorced from a number of kindred subjects, stands in the most intimate, almost inseparable, connection with them.

The student is encouraged at all times to make careful objective drawings of what he sees.

Text-books in English, German and French are used in the course, and in addition each student is required to read original articles in the literature and to make a careful abstract of at least one scientific article. In this way he gains the habit of going to the sources for his information, is impressed with the limitations of histological knowledge, sees the lines along which original research is moving, and learns the origin of text-books.

It will be observed in perusing the list, that whereas none of the important organs have been omitted, certain parts of the body have been studied in more detail than others. This we think unavoidable, but we have arranged the subjects so that especial attention should be given to those parts of the body in which at present most advance is being made. Thus the sense organs and nervous system, it will be seen, have been examined in considerable detail, and as far as possible the students are made conversant with the newer ideas concerning the minute anatomy and histogenesis of the peripheral and central portions of the nervous system. Preceding this portion of the work, six half-days, in addition to the time allotted to the subject in the course, are given to the student for the study of the gross anatomy of the central nervous system. A series of sections at various levels of the spinal cord and brain are then carefully studied and drawn, and finally several days are devoted to the study of tracts, thus bringing the student's knowledge together in a more or less orderly fashion. Our experience, though brief, has confirmed us in our belief that the histology and microscopic anatomy of the nervous system are properly, for the present at least, included in this course. Much has been demanded of the students, but within certain limits, students, we think, do more thorough work when much is expected of them.

In choosing the methods mentioned in the following list we have been influenced in a given instance sometimes by one factor, sometimes by another. When the method suggested seems at first less desirable than certain others which are in vogue and which could have been selected, it should not be taken for granted that the other method has not been thought of. It may be that the method in question has been chosen to suit a certain particular condition in the course. Still we know only too well that there are many ways in which the list can be improved, and not a few errors which would be better eliminated. We shall be particularly grateful for corrections or suggestions from those who take an interest in the subject. It is an especial pleasure in closing to acknowledge our indebtedness to Professor Mall for helpful counsel and manifold suggestion.

The method here used for designating the main steps employed in preparing the various tissues for histological study was devised as a convenient means of briefly indicating the necessary technique when planning out the work of the course. The writing out in full of the technique used for each tissue was found to take too much time and to be needlessly cumbersome. Word-abbreviation was too apt to be confusing, and thus a completely artificial system seemed on the whole to be the best.* The various technical processes employed in histological study were roughly arranged in eleven-odd groups: *fresh examination, dissociation, decalcification, fixation, hardening, microscopic preparation, staining, clearing, fastening, mounting,* and *special,* and each of these groups was designated by a particular letter of the alphabet. Thus, for example, all the methods used for staining are grouped under "G." The various methods in each group are further designated by numbers, thus *e. g.* staining with borax-carmine is indicated by "G_1"; furthermore, since certain of the technical steps are carried out by the instructors and certain of them by the students, the group representing the particular process is written (or printed) as a "capital" when representing work done by the instructor, as a "small letter" when it is done by the student. An example will make this clear: In indicating the methods used in preparing the cardiac end of a dog's stomach for microscopic examination, the following signs are used: "D_{12}; E_2; F_9; $g_{2,12}$; k_6," which being interpreted means that the tissue was (1) fixed in Zenker's fluid; (2) hardened in graded alcohols; (3) embedded and sectioned in celloidin by the instructor; and by the student (4) stained in hæmatoxylin and eosin; and (5) mounted in balsam. Only the more important steps, or those to which especial attention is to be called, are indicated, thus the clearing agent most often used in the daily routine of the classroom, carbol-xylol, "H_1," is seldom put down among the steps of the technique.

With this explanation it is hoped that the following tables and the programme will be clearly self-explanatory. The technical methods used are, in the main, those commonly given by the various books on technique, though many of them have been taken from the literature, and a number have been slightly modified to suit our own needs or preferences.

EXPLANATION OF ABBREVIATIONS EMPLOYED.

A.—Methods of Preservation or Examination in Natural State.

(1) Fresh tissues.

*The method for a similar purpose used by Benda in the "Histologischer Hand-Atlas" of Benda and Guenther (Leipzig, 1895) suggested the method here employed.

(2) Tissues in normal fluids.
(3) Tissues in physiological salt solution.
(4) Tissues in aqueous humor.
(5) Tissues in blood serum.
(6) Tissues in iodized serum.
(7) Tissues in Farrant's medium.
(8) Tissues in 1 per cent. sugar solution.

B.—METHODS OF DISSOCIATION, MACERATION, CORROSION OR ALTERATION.

(1) 0.25 per cent. ac. acetic.
(2) 30 per cent. potassic hydrate.
(3) 33⅓ per cent. alcohol (Ranvier's alcohol).
(4) 0.1 per cent. osmic acid.
(5) Conc. ac. hydrochloric.
(6) Conc. ac. nitric.
(7) Müller's fluid.
(8) 0.1 per cent. potass. bichromat.
(9) 0.5 per cent. ac. chromic.
(10) 0.5 per cent. ammon. chromat.
(11) Digestion with pancreatin and sod. bicarb.
(12) Digestion with pepsin and ac. hydrochlor.
(13) Iodized serum.
(14) Water.
(15) 20 per cent. ac. acetic.
(16) Conc. ac. sulphuric.
(17) Lugol's solution.
(18) Sat. sol. tannic acid.
(19) 0.05 per cent. ac. chromic.

C.—METHODS OF DECALCIFICATION.

(1) 3 to 5 per cent. ac. nitric.
(2) 2 per cent. ac. chromic.
(3) Ac. acetic glaciale.
(4) Müller's fluid.
(5) Per cent. ac. picric.
(6) Per cent. hydrochlor.
(7) v. Ebner's fluid.
(8) Phloroglucin + ac. nitric (Haug).

D.—METHODS OF FIXATION.

(1) Heat on copper bar at 120° C.
(2) Boiling water.
(3) Steam.
(4) Absolute alcohol.
(5) Flemming's solution.
(6) Hermann's solution.
(7) Fol's solution.
(8) Osmic acid vapor.
(9) 1 per cent. osmic acid.
(10) 10 per cent. ac. nitric.
(11) Sat. sol. hydrarg. perchlor. in 0.75 per cent. NaCl solution.
(12) 5 per cent. formaldehyde.
(13) Zenker's fluid.
(14) Bethe's fluid.
(15) Kleinenberg's solution.
(16) Equal parts abs. alcohol and ether.

E.—METHODS FOR HARDENING* SOMETIMES USED FOR FIXING, ETC.

(1) Graded alcohols 33⅓ per cent., 50 per cent., 70 per cent., 80 per cent., 90 per cent., 95 per cent., absolute.
(2) Graded alcohols 80, 95, absolute.
(3) 95 per cent. alcohol.
(4) Müller's fluid.
(5) Müller's fluid 3 pts. + alcohol (95 per cent.) 1 pt.
(6) Erlicki's fluid.
(7) 1 per cent. ac. chromic.
(8) 5 per cent. formaldehyde.
(9) Cox's solution.
(10) Cajal's osmo-bichromic solution (rapid Golgi method).
(11) 2 pts. Müller's fluid + 1 pt. 1 per cent. ac. osmic (*Marchi*).
(12) Weigert's mordant for neuroglia.
(13) Distension and drying.

F.—METHODS OF PREPARATION FOR MICROSCOPIC EXAMINATION.

(1) Transfer simply to slide.
(2) Spread out thin on slide.
(3) Semi-desiccation method.
(4) Teasing.
(5) Strip off in layers.
(6) Free-hand section.
(7) Section with Valentine's knife.
(8) Frozen section.
(9) Celloidin section.
(10) Paraffin section.
(11) Dissection.
(12) Elder-pith section.
(13) Grinding and polishing.
(14) Cullen's formaline method.

G.—METHODS OF STAINING AND IMPREGNATION.

(1) Borax carmine.
(2) Alum cochineal.
(3) Indigo-carmine.
(4) Picro-carmine.
(5) Upson's carmine.
(6) Van Gieson's fluid.
(7) Delafield's hæmatoxylin.
(8) Böhmer's hæmatoxylin.
(9) Heidenhain's hæmatoxylin.
(10) Weigert's myelin stain.
(11) Weigert-Pal myelin stain.
(12) Ehrlich's acid hæmatoxylin.
(13) Eosin.
(14) Acid fuchsin.
(15) Acid picric.
(16) Safranin.
(17) Methylene blue.
(18) Aqueous magenta.
(19) Dahlia.
(20) Methyl violet.
(21) Ehrlich's triple stain.
(22) Weigert's fibrin stain.
(23) Weigert's neuroglia stain.
(24) Mall's reticulum stain.
(25) Boiled gold chloride methods.
(26) Löwit's gold method.
(27) Golgi's gold method.
(28) Lemon juice gold method.
(29) 0.75 per cent. argent. nitrat.
(30) Silver nitrate + ammon. hydrat.
(31) Lavdowsky's modification of Ehrlich's methylene blue method.
(32) Nissl's methylene blue and soap solution.
(33) Thionin.
(34) Gerlach's gold chloride solution.
(35) Benda's iron hæmatoxylin.
(36) Aniline blue.

H.—METHODS OF CLEARING.

(1) Carbol-xylol (ac. carbol. pur. xtls. 1 + xylol 3).
(2) Xylol.
(3) Creasot.
(4) Ol. caryophyll.
(5) Ol. bergamot.
(6) Ol. origanum.
(7) Ol. cajeput.
(8) Acid glycerine.
(9) Glycerine.

I.—METHODS OF FASTENING SECTIONS TO SLIDE.

(1) Mayer's albumen.
(2) Gulland's water method.
(3) Schallibaum's collodion method.
(4) Clove oil collodion method.
(5) Obreggia's collodion-paraffin method.

K.—METHODS OF MOUNTING.

(1) Glycerine pur.
(2) Glycerine 20 + ac. arsenios. trace + water 80.
(3) Farrant's medium.
(4) Sat. sol. potass. acetat.
(5) Xylol balsam.
(6) Dammar.
(7) Benzol-colophonium.
(8) Physiological salt solution.
(9) Glycerine and alcohol with or without acid.

L.—OTHER METHODS OF PREPARATION.

(1) Injection with aqueous Berlin blue.
(2) Injection with carmine gelatine.
(3) Injection with Berlin blue gelatine.
(4) Injection with cinnabar gelatine.
(5) Injection with methylene blue (intra vitam).
(6) Feeding with madder.
(7) Artificial œdema.

* The line between fixing and hardening fluids must of necessity be an artificial one. We have designated as fixing fluids those commonly allowed to act for twenty-four hours or less on the tissues; as hardening fluids those used a longer time than this.

PREPARATIONS.

Subject.	Special Features Illustrated.	Animal.	Methods Employed.
Fabric fibres, etc.	Wool.		A_1; f_1.
	Cotton.		
	Linen.		
	Silk.		
	Rabbit's hair.		A.
	Human hair.		
	Air bubbles.		
	Oil droplet.		
Vegetable cells.	Cells in onion leaf.		A_2; { (1) $f_{5\ 2}$; a_5; b_{17}; afterwards b_{16}. (2) $f_{5\ 2}$; g_{17}.
	Cells in potato, cell contents.		A_2; f_6; b_{17}; afterwards b_{16}.
	Cell division in onion tip.		D_6; E_2; F_{10}; I_1; G_{16}; H_1; K_5.
	" " in fritillaria.		D_5; E_2; F_{10}; I_1; G_{16}; H_1; K_5.
Animal cell.	Saliva and scraping from cheek.		a_5; afterwards b_{15}.
	Echinoderm ova—fertilized (1–16 cell stages).		D_{15}; E_2; k_5.
	Early embryonic cells:		
	in (1) cross section 1 day chick.		D_{10}; E_1; G_7; F_{10}; i_1; h_5; k_5.
	(2) " " 3 day "		D_{10}; E_1; G_7; F_{10}; i_1; h_5; k_5.
	Cell division in tongue.	Newt.	D_6; E_2; F_{10}; I_1; G_{16}; H_1; K_5.
	" " in testicle.	Mouse.	D_6; E_2; F_{10}; I_1; G_{16}; H_1; K_5.
	Centrosome and attraction-sphere.		Demonstration.
	Amitotic cell division.		Demonstration.
	Altmann's granula.		Demonstration.
Epithelium.	Shed skin—squamous epithelium.	Frog.	E_2; f_2; afterwards g_5; h_1; k_5.
	Cornea of embryo.	Pig.	A_1; f_2; afterwards g_{17}.
	Cornea.	Dog.	B_2; f_1; k_5.
	Transitional epithelium of bladder.	Dog.	B_3; f_4; k_5.
	Columnar epithelium and goblet cells, intestine.	Human.	B_3; f_4; k_5.
	Stratified epithelium of skin.	Human.	B_3; f_4; k_5.
	" " " mouth.	Human.	B_3; f_4; k_5.
	Ciliated epithelium of bronchi.	Human.	B_3; f_4; k_5.
	Epithelium in section of cornea.	Rabbit.	D_{11}; E_2; F_9; g_5; h_1; k_5.
	" " " " small intestine.	Dog.	D_{11}; E_2; F_9; g_5; h_1; k_5.
	Living ciliated cells.	Oyster.	A_1; f_2.
	" " "	Frog.	Demonstration.
	Glandular epithelium—kidney.	Dog.	$B_{5\ 14}$; f_4.
	" " liver.	Dog.	B_3; f_4.
	Frozen section—kidney.	Dog.	F_8; a_5.
	Pigmented epithelium of retina.	Dog.	B_3 for 2 days; f_4; k_2.
	Lens fibres.	Dog.	B_3 for 2 days; f_4; k_2.
Connective tissues.	Mucoid tissue, section umbilical cord.	Human.	$E_{4\ 2}$; F_9; $g_{7\ 13}$; k_5.
	Fœtal conn. tissue, tendon.	Embryo pig.	B_{17}; f_4; g_4; k_2.
	Endothelium, mesentery.	Rabbit.	A_1; g_{29}; $e_{8\ 2}$; h_1; k_5.
	Subcut. areolar tissue.	Rabbit.	A_1; L_7; f_3; afterwards g_{18}; k_5.
	White fibrous tissue, tendon.	Dog.	B_3; G_2; f_4; k_2.
	in corium of skin.	Human.	D_4; f_9; $g_{7\ 13}$; k_5.
	Conn. tiss. corpuscles of cornea.	Rabbit.	G_{26}; f_9; h_1; k_5.
	Cornea in frozen section.	Dog.	F_8; a_5; afterwards g_{17}.
	Pigmented conn. tiss. cells in penis.	Terrapin.	E_2; F_9; $g_{7\ 13}$; k_5.
	Mastzellen stained with "polychrome" methylene blue.		Demonstration.
	Yellow elastic tissue in lig. nuchæ.	Ox.	A_1; f_6; afterwards g_{18}.
	Membrane of elastic fibre—contents.	Ox.	B_{11}; f_4; g_{18}.
	Elastic membrane—artery.	Dog.	A_1; f_5.
			B_2; f_4.
	Reticulum—lymph gland.	Dog.	F_8; B_{11}; f_3; g_{24}.
	" " "	Dog.	F_8; b_2.
	Gelatine manufacture.		Demonstration.
	Chemical reactions of the connective tissues.		Demonstration.
Cartilage.	Simple cellular.	Embryo pig.	A_1; f_6; a_8; afterwards g_{17}.
	Hyaline—general structure in rib.	Ox.	A_1; f_6; a_8; afterwards b_{15}.
			A_1; f_6; g_{17}.
	on articular surface.	Ox.	A_1; f_6; b_{17} for glycogen.
	White fibro-cartilage—intervertebral disc.	Dog.	A_1; f_6; b_{17}.
	Yellow elastic cartilage in ear.	Dog.	D_{15}; E_2; F_9; $g_{7\ 13}$; k_5.
Smooth muscle.	Cells in tunica muscularis of intestine.	Dog.	A_1; f_5; a_8; afterwards g_{17}.
	Cells in tun. musc. of pregnant uterus.	Pig.	B_9; f_4.
	Embryo smooth muscle.	Pig.	E_6; f_4; g_4.
	Piece of wall of distended bladder.	Frog.	D_4; $g_{7\ 13}$; k_5.
	Section of smooth muscle-intestine.	Dog.	(Already prepared under epithelium.)
Voluntary muscle.	Appearance of fresh tissue.	Frog.	A_1; f_4; a_3; afterwards g_{17}.
	Dissociated fibres.	Dog.	B_2; f_4.
	Muscle from embalmed subject.	Human.	Muscle from dissecting room; f_4; k_2.
	Muscle-fibrillæ.	Frog.	E_7; E_3; f_2.
	Cohnheim's fields.	Insect, dog.	G_{26}; E_2; F_{10}; i_1; k_5.
	Embryonic fibres.	Pig.	B_{17}; f_4.

SUBJECT.	SPECIAL FEATURES ILLUSTRATED.	ANIMAL.	METHODS EMPLOYED.
The neurone.	Cell elements in adult spinal cord.	Ox.	A_1; g_{17}.
			B_3; G_1; f_4.
	Cell elements in spinal ganglion.	Dog.	D_9 for ¾ hour; glyc. $_1$ + ac. acetic $_1$ for from 3 to 4 days; f_4; (Schiefferdecker, p. 227).
	Cells in sympathetic ganglia.	Frog.	D_9 for ¾ hour; glyc. $_1$ + ac. acet. $_1$ for 3 days; f_4.
	Examples in embryo spinal cord.	Pig.	E_{10}; G_{29}; F_9; H_5; k_5.
	Section of spinal ganglion.	Dog.	D_9; E_2; F_9; G_5; k_5.
	Section of cervical sympathetic ganglion.	Dog.	D_9; E_2; F_9; G_5; k_5.
Nerves.	Fresh sciatic nerve.	Dog.	A_1; b_{14}.
	Ranvier's silvered nerve.	Dog.	G_{29}; expose to light; f_4.
	Silvered nerve.	Dog.	Vide article by Golgi, Nervensystem, p. 63.
	Osmic preparation.	Dog.	B_3; f_4.
	Axones.	Dog.	½ per cent. osmic 4 hours; 90 per cent. alc. 24 hours; wash in H_2O; sol. ac. fuchsin 24 hours; abs. alc. 3 days; toluol; celloidin.
	Axones.	Dog.	$E_{4\ 2}$; F_9; $g_{36\ 16}$; h_2; k_5 (Ströbe).
	Fresh splanchnic nerve.	Dog.	A_1; f_4.
	Cross section of sciatic nerve.	Dog.	$E_{7\ 2}$; F_9; g_5; k_5.
	Cross section of splanchnic nerve.	Dog.	$E_{7\ 2}$; F_9; g_5; k_5.
Nerve endings.	Motor endings in vol. muscle.	Frog.	May's method.
	Free nerve endings in epithelium of cornea.	Frog.	G_{29}; E_2; F_9; h_1; k_5.
	Pacinian corpuscles.	Cat.	A_1; a_3; afterwards b_{15}.
	Meissner's corpuscles.	Human.	D_4; F_9; $g_{7\ 13}$; k_5.
	Nerve endings in frog's tongue, pig's snout and human skin, with vital methylene blue staining.		Demonstration.
Blood.	Fresh blood from ear.	Human.	Test with b_{14}; b_{15}; b_{18}; b_2.
	" " " frog.	Frog.	
	Technique of fresh blood slide.	Human.	A.
	Blood platelets.	Human.	Prick finger through g_{30} (1–100,000).
	Fibrin.	Human.	Coagulation beneath cover-glass.
	Fibrin in tissues stained with Weigert's fibrin stain.		Demonstration.
	Blood of other animals.	Bird, Dog, Cat, Rabbit.	Demonstration.
	Technique of Ehrlich's method of drying and staining, and the varieties of white corpuscles in the blood.	Human.	D_1; g_{21}; k_5.
	Nikiforoff's method.	Human.	D_{16}; $g_{17\ 13}$; k_5.
	Nuclei of white corpuscles.	Human.	Blood mixed with drop of D_6.
	Eosinophiles in horse's blood; iron in eosinophile granules; mastzellen; myelocytes.		Demonstration.
	Hæmoglobin crystals.	Rat.	Blood made laky and then placed in stoppered bottle to crystallize.
	Hæmin crystals.	Human.	$NaCl + HC_2H_3O_2$ (glacial) and heat.
	Mastzellen in tongue.	Dog.	D_1; F_9; g_{19}; k_5.
	Hæmoglobinometer, Hæmocytometer, Hæmatokrit.		Demonstration.
	The circulating blood in mesentery and tongue.	Frog.	Demonstration.
Heart.	Dissection of heart.	Sheep.	A_1; f_{11}.
	Fresh elements of heart muscle.	Sheep.	B_2; f_4.
	" " " " "	Human.	F_6; a_3.
	Purkinje fibres.	Sheep.	A_1; f_4.
	Cross section of papillary muscle.	Dog.	$L_{1\ 2}$; E_2; F_9; $g_{7\ 13}$; k_5.
	Section of heart wall and mitral valve.	Dog.	$L_{1\ 2}$; E_2; F_9; $g_{7\ 13}$; k_5.
	" " " " aortic valve.	Dog.	$L_{1\ 2}$; E_2; F_9; $g_{7\ 13}$; k_5.
Arteries, veins and capillaries.	Dissection of walls of medium-sized artery. Portions dissected off to be examined microscopically.	Dog.	B_2; f_{11}.
	Cross section of aorta.	Cat.	D_3; E_2; F_9; g_{16}; h_4; k_5.
	" " " femoral artery and vein.	Cat.	D_3; E_2; F_9; g_{16}; h_4; k_5.
	Capillaries from pia mater.	Human.	D_{12}; f_4; g_4.
	Silvered mesentery.	Cat.	g_{29}; d_{12}; c_3; h_1; k_5.
Lymph glands and lymphatics.	Cross section of thoracic duct.	Dog.	D_3; E_2; F_9; g_{16}; k_5.
	Sagittal section of lymph gland.	Ox.	D_{11}; E_2; F_9; $g_{7\ 13}$; k_5.
	Injected lymphatic gland.	Dog.	$L_{1\ 2\ 3}$; E_5; F_9; h_1; k_5.
	Unstained lymph gland.	Dog.	A_1; F_{14}.
	Framework.		Cf. mounted section of reticulum.
Spleen.	Appearances in gross.	Human.	A_1.
		Pig.	A_1.
	Fresh scraping from surface.	Pig.	A_1; f_4; a_3; afterwards b_{15}.
	Smear cover-glass preparation.	Pig or human.	D_1; (Ehrlich's copper bar); g_{21}; k_5.
	Section.	Human.	D_3; E_2; F_9; g_{16}; h_4; k_5.
	Injected organ.	Dog.	$L_{1\ 2}$; E_5; F_9; h_1; k_5.
	Framework.	Dog	Demonstration of dried specimens

Subject.	Special Features Illustrated.	Animal.	Methods Employed.
Bone.	Architecture of femora.	Human.	Dried bone sawed through longitudinally.
	Elements of bone marrow.	Dog.	A_1; a_3; afterwards g_{17}.
	Elements of marrow.	Dog.	d_6; f_4.
	Section of marrow.	Dog.	D_5; E_2; F_{10}; i_1; g_{35}; k_5.
	Longitudinal section of decalc. bone.	Dog.	L_3; E_4; C_1; F_9; $g_{7\ 13}$; k_5.
	Cross section of decalc. bone.	Dog.	E_4; C_1; F_9; b_{15}; g_3; k_5.
	Longitudinal and cross section dried bone.	Human.	Demonstration; also with polarization microscope.
Developing bone and muscle.	Finger.	Human fœtus.	$E_{4\ 2}$; C_1; F_9; $g_{7\ 13}$; k_5.
Tendon and muscle as organs.	Injected blood-vessels in muscle and tendon.	Rabbit	$L_{1\ 2}$; E_5; f_6, h_1; k_5.
	Cross section of tendon.	Dog.	$E_{4\ 2}$; F_9; g_4; k_5.
	Nerve endings in tendons and muscles.		Demonstration.
Alimentary Tract.	Dissection of alimentary tract from mouth to anus.	Embryo pig.	A_1; f_{11}.
Mouth and tonsil.	Section of lip.	Baby.	E_3; F_9; $g_{7\ 13}$; k_5.
	Section of palatine tonsil.	Human.	D_{13}; E_2; F_9; $g_{7\ 13}$; k_5.
	Blood-vessels of tonsil.	Cat.	L_4; E_5; G_1; F_9; h_1; k_5.
Tongue.	General structure in longit. section.	Rat.	E_3; F_9; $g_{7\ 13}$; k_5.
	Tip of tongue and filiform papillæ.	Human.	D_4; F_9; $g_{7\ 13}$; k_5.
	Side of tongue.	Human.	D_4; F_9; $g_{7\ 13}$; k_5.
	Vallate papillæ and tonsilla lingualis.	Human.	D_4; F_9; $g_{7\ 13}$; k_5.
	Papilla foliata.	Rabbit.	D_6; E_2; F_{10}; g_{16}; h_4; k_5.
Teeth and salivary glands.	Parotid gland, resting.	Rabbit.	D_{13}; E_2; F_9; $g_{7\ 13}$; k_5.
	" " active.	Rabbit.	
	Submaxillary gland.	Human.	D_{11}; E_2; g_{35}; k_5.
	Sublingual gland.	Human.	D_{13}; E_2; F_9; $g_{7\ 13}$; k_5.
	Adult tooth, longit. section.	Human.	f_{13}; k_5.
	Developing tooth in lower jaw.	Embryo pig.	E_4; C_1; E_3; F_9; $g_{7\ 13}$; k_5.
Oesophagus and stomach.	Cross section œsophagus—upper part.	Human.	E_3; f_9; $g_{7\ 13}$; k_5.
	" " " lower part.	Human.	
	Longit. section and blood-vessels of œsophagus and cardiac end of stomach.	Cat.	L_1; E_5; G_1; F_9; k_5.
	Longit. section through whole stomach.	Rat.	D_{13}; E_2; F_9; $g_{7\ 13}$; k_5.
	Section of cardiac end.	Dog.	D_{11}; E_2; F_9; $g_{7\ 13}$; k_5.
	" middle region.	Dog.	D_{11}; E_2; F_9; $g_{7\ 13}$; k_5.
	" pyloric end and beginning of duodenum.	Dog.	D_{11}; E_2; F_9; $g_{7\ 13}$; k_5.
	Secretion-canaliculi on parietal cells.	Dog.	E_{10}; G_{29}; F_9; k_5.
Intestine.	Dissection and low power microscopic examination of layers of small intestine.	Dog.	a_1; f_{11}.
	Cross section of small intestine.	Dog.	E_3; F_9; $g_{7\ 13}$; k_5.
	Longit. section through Peyer's patch.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	Blood-vessels and lymphatics.	Rabbit.	$L_{1\ 3\ 4}$; F_9; k_9.
	Auerbach's plexus,	Guinea pig.	G_{28}; $f_{11\ 2}$; k_9.
	Meissner's plexus.		
	Vermiform appendix in transv. section.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	Large intestine—cross-section.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	Longit. section through anus.	Baby.	D_4; F_9; $g_{7\ 13}$; k_5.
Pancreas.	General structure.	Dog.	D_{13}; E_2; F_9; $g_{7\ 13}$; k_5.
	Blood-vessels.	Cat.	L_1; E_5; G_1; F_9; k_9.
	Finer cell structure—(Altmann's granules).	Cat.	Altmann's method.
Liver.	Lobular structure.	Pig.	D_4; F_9; $g_{7\ 13}$; k_5.
	" "	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	Blood-vessels.	Rabbit.	$L_{3\ 4}$; E_5; F_9; k_9.
	Bile-capillaries.	Human.	E_{10}; G_{29}; F_9; k_5.
	Kupffer's cells.	Human.	F_5; B_{19}; G_{34}; k_1.
	Fresh tissue.	Human.	F_5; a_3.
	Embryonic appearances.	Embryo pig.	D_{11}; E_2; F_9; $g_{7\ 13}$; k_5.
Thyroid.	Section including so-called "embryonic nodule."	Dog.	D_4; F_9; $g_{7\ 13}$; k_5.
Thymus.	Section.	Baby.	D_4; F_9; $g_{7\ 13}$; k_5.
The Respiratory System.			
Epiglottis, larynx and trachea.	Longit. section through the tissue.	Rat.	E_3; F_9; $g_{7\ 13}$; k_5.
Lungs.	Dissection of trachea and lungs.	Embryo pig.	A_1; f_{11}.
	Elements.	Dog.	B_3; f_4; k_2.
	Section adult lung.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	Blood-vessels of lung—(section through root).	Dog.	$L_{3\ 4}$; E_5; F_9; k_9.
	Shaving of dried injected lung.	Dog.	L_1; E_{13}; F_6; k_9.
	Frozen section and elastic tissue.	Dog.	A_1; F_6; a_5; afterwards b_2.
	Development of lung.	Human fœtus.	E_3; F_9; $g_{7\ 13}$; k_5.

SUBJECT.	SPECIAL FEATURES ILLUSTRATED.	ANIMAL.	METHODS EMPLOYED.
GENITO-URINARY ORGANS.			
Kidney.	(1) Isolated units.	Dog.	B_3; f_4.
	(2) Vertical section for blood-vessels. } (3) Tangential section for blood-vessels. }	Cat.	$L_{1\ 2}$; E_3; F_6; h_4; k_5.
	(4) Vertical section through renculus.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	(5) Cell details in cortex.	Dog.	D_6, E_2; F_{10}; i_1; g_{16}; h_4; k_5.
	(6) Developing kidney.	Embryo pig.	D_{13}; E_2; F_9; $g_{7\ 13}$; k_5.
	(7) Appearance of fresh tissue.	Dog.	A_1; f_3; k_5; afterwards g_{17}.
Ureter.	(1) Cross section.	Dog.	E_3; F_9; $g_{7\ 13}$; k_5.
Bladder.	(1) Section through walls of contracted organ.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	(2) Section through wall of organ distended.	Dog.	D_4; F_9; $g_{7\ 13}$; k_5.
Testicle.	(1) General structure.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	(2) Spermatogenesis.	Mouse.	D_6; F_{10}; i_1; g_{16}; h_4; k_5.
	(3) Isolated tubules.	Dog.	B_3; f_4.
Semen.	Spermatozoa.	Human.	A_1; a_1; afterwards g_{17}.
Vas deferens.	Cross section.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
Prostate and pars urethra.	Section.	Human.	D_{13}; E_2; F_9; $g_{7\ 13}$; k_5.
Vesiculæ seminales.	Section.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
Ovary.	General structure in young adult.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	Structure in pregnant animal.	Dog.	E_3; F_9; $g_{7\ 13}$; k_5.
	Blood-vessels in ovary and longit. section of Fallopian tube.	Cat.	$L_{1\ 2}$; E_3; F_9; $g_{7\ 13}$; k_5.
	Blood-vessels in ovary.	Human.	$L_{1\ 2}$; E_3; F_6; k_9.
Fallopian tube.	Cross section.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
Uterus and vagina.	General longit. "oversight" section.	Cat.	$L_{1\ 2}$; E_3; F_9; $g_{7\ 13}$; k_5.
	Wall of body of uterus.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	Longit. section of cervix, including cervical canal.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	Pregnant uterus (Decidua).	Human.	$E_{4\ 2}$; F_9; $g_{7\ 13}$; k_5.
	General structure of the placenta and its blood-vessels	Human.	$L_{1\ 2}$; E_3; F_9; $g_{7\ 13}$; k_5.
	Cross section of vagina.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
Penis.	Transverse section.	Dog.	E_4; C_1; E_2; F_9; $g_{7\ 13}$; k_5.
	Transv. section adult.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
	Longit. section of glans and prepuce.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
Cowper's glands.	Section through penis and gland.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
Clitoris and urethra.	Longit. section bladder, urethra and clitoris.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
Bartholine's glands.	General structure.	Human.	E_3; F_9; $g_{7\ 13}$; k_5.
Adrenal.	General structure.	Human.	E_4; F_9; $g_{7\ 13}$; k_5.
SENSE ORGANS.			
Skin.	Palm of hand.	Human.	D_4; F_9; $g_{7\ 13}$; k_5.
	Back of wrist.	Human.	D_4; F_9; $g_{7\ 13}$; k_5.
	Finger tip.	Human.	D_5; E_2; F_{10}; i_1; g_{16}; h_4; k_5.
	Elements.	Human.	B_{11}; f_4.
Eyelid.	General structure.	Baby.	E_3; F_9; $g_{7\ 13}$; k_5.
Lip.	Junction of skin and muc. memb.		Cf. alim. tract.
Skin.	Blood-vessels.	Human.	L_3; E_3; F_9; h_4; k_5.
Nail.	Cf. also section of baby's finger showing developing bone.	Human.	B_2; f_4.
Scalp.	Hairs and follicles.	Human.	$E_{4\ 2}$; F_9; (iodine-green method).
Hair.	Elements.	Human.	a_1; b_{16}; f_4.
Hair follicle.	Elements.	Human.	B_{15} (2 days); f_4.
Mammary gland.	General structure.	Human.	D_4; F_9; $g_{7\ 13}$; k_5.
Milk.	Elements.	Cow and human	a_1.
Nose.	General dissection of.	Embryo pig.	A_1; f_{11}.
	General structure of cavities and septum in vertical section.	Baby.	E_4; C_1; E_2; F_9; $g_{7\ 13}$; k_5.
	Elements of mucous membrane.	Dog.	$B_{4\ 2}$; G_1; f_4.
	Section of mucous membrane.	Guinea pig.	D_5; E_2; G_1; F_{10}; i_3; k_5.

Subject.	Special Features Illustrated.	Animal.	Methods Employed.
Nose.	Alæ nasi and respirat. muc. memb.	Baby.	E_3; F_9; $g_{7\ 13}$; k_5.
	Nerves in muc. memb., cribrif. plate and olfactory bulb.	Embryo pig.	2 (E_{10} G_{29}); D_4; F_9; H_5; K_5.
Eye.	General relations.	Pig.	f_{11}.
	Structure in horizontal section through cornea, lens, optic nerve, ciliary region and retina.	Guinea pig.	E_7; E_2; F_9; $g_{7\ 13}$; k_5.
Cornea.	Matrix—negative picture.	Rabbit.	Stick $AgNO_3$.
	Matrix—positive picture.	Dog.	G_{26}; F_9; k_5.
	Nerves.	Embryo pig.	G_{31}; D_{14}; F_{10}; i_1; g_2; k_5.
Lens.	Fibres.	Cat.	B_3; separate capsule after 2 hours; return to B_3 for 24 hours; f_4; k_2.
Retina.	Elements.	Pig embryo.	D_9; B_{14} for 2 days; f_4; k_2.
	Nerve elements.	Pig embryo.	G_{31}; D_{14}; F_{10}; i_1; g_2; k_5.
	Nerve elements.	Pig embryo.	G_{27}; F_9; K_5.
Eyeball.	Distribution of blood-vessels.	Cat.	$L_{1\ 2}$; E_3; F_9; h_1; k_5.
Lachrymal gland.	General structure.	Human.	D_{13}; E_2; F_9; $g_{7\ 13}$; k_5.
Optic nerve.	Structure in cross section.	Human.	$E_{5\ 2}$; F_9; G_{11}; H_1; K_5.
	Long. section through optic nerve, chiasm, and optic tract.	Pig embryo.	$E_{5\ 2}$; F_9; G_{11}; H_1; K_5.
Whole ear.	General relations.	Embryo pig.	a_1; f_{11}.
External ear.	Transv. section of soft parts of ext. auditory canal.	Human.	D_4; f_9; $g_{7\ 13}$; k_5.
Middle ear.	General structure.	Dog.	E_4; C_5; E_2; F_9; $g_{7\ 13}$; k_5.
Internal ear.	General view of cochlea, sacculus and semicircular canals.	Baby.	E_4; C_1; E_2; F_9; $g_{7\ 13}$; k_5.
	Cochlea—vertical section.	Guinea pig.	D_9; E_2; C_1; E_2; G_1; F_{10}; i_3; k_5.
	Nerves and nerve endings at base of skull.	N. born mouse.	2 (E_{10}; G_{29}); D_4; F_9; H_5; K_5; (cf. v. Lenhossek).
	Nerves and nerve endings.	Guinea pig.	Retzius' method (cf. Böhm and v. Davidoff, p. 372).
Central Nervous System.			
Embryonic nervous system.	General form—relations of central nervous system in advanced embryo.	Embryo pig.	f_{11}. (To be preserved in formaline and used for reference throughout the course.)
	Transv. section—1 day chick.	Emb. chick.	Cf. sections given for study of animal cell.
	" " 3 " "	Emb. chick.	
	Longit. section young pig embryo.	Emb. pig.	D_{10}; E_2; F_9; $g_{7\ 13}$; k_5.
	Transv. section through region of third ventricle.	Emb. pig.	D_{10}; E_2; F_9; $g_{7\ 13}$; k_5.
Spinal cord.	Structure in transv. section and technique of Weigert's stain.	Dog.	E_4; F_9; g_{10}; h_1; k_5.
	Another section in Upson's carmine.	Dog.	E_3; F_9; g_5 over night; k_5.
	Transv. section cervical enlargement.	Human.	E_3; F_9; G_{11}; H_1; k_5.
	" " thoracic cord.	Human.	"
	" " lumbar cord.	Human.	"
	Longitudinal section cervical cord.	Human.	"
	(*a*) laterally.	Human.	"
	(*b*) through mid. of hemisphere antero-posteriorly.	Human.	"
	Transv. section below hemi-section.	Monkey.	$E_{4\ 11}$; E_2; F_9; h_1; k_5.
	" " above hemi-section.	Monkey.	$E_{4\ 11}$; E_2; F_9; h_1; k_5.
	" " asc. deg. after section of post. roots.	Monkey.	$E_{4\ 11}$; E_2; F_9; h_1; k_5.
	" " descending degeneration.	Human.	E_3; F_9; G_{11}; H_1; K_5.
	" " ascending degeneration.	Human.	E_3; F_9; G_{11}; H_1; K_5.
	Study Golgi cord.		Cf. section given for study of neurone.
	Frozen section spinal cord.	Dog.	A_1; F_8; a_2.
	Structure of nerve cells in cord.	Dog.	D_3; F_{12}; G_{32}; H_7; K_7.
	Cord of fœtus nearly full term to show non-medullated pyramidal tracts.	Human.	E_4; F_9; G_{11}; H_1; K_5.
Myelencephalon and nerves directly connected with it.	Two transverse sections.	Adult human.	$E_{8\ 3}$; F_9; G_5; k_5.
	Six transverse sections.	Adult human.	$E_{8\ 4\ 3}$; F_9; G_{11}; H_1; K_5.
	Sec. through decussation of pyramids, after extirpation of thumb area in cortex.	Monkey.	$E_{8\ 4\ 11}$; F_9; H_1; K_5.
	Longitudinal section through pons and medulla.	Adult human.	$E_{8\ 4\ 3}$; F_9; G_{11}; H_1; K_5.
Metencephalon and nerves directly connected with it.	Four transverse sections at different levels through pons varolii.	Adult human.	$E_{8\ 4\ 3}$; F_9; G_{11}; H_1; k_5.
	Tr. section through pons in region of sup. olivary complex.	Cat.	$E_{8\ 4\ 3}$; F_9; G_{11}; H_1; K_5.
	Section of cerebellar cortex, including dentate nucleus.*	Cat.	$E_{8\ 4\ 2}$; F_9; G_{11}; H_1; K_5.
	Finer structure of cerebellar cortex.	Cat.	E_4; G_{29}; F_9; h_5; k_5.

SUBJECT.	SPECIAL FEATURES ILLUSTRATED.	ANIMAL.	METHODS EMPLOYED.
Mesencephalon, Diencephalon and nerves directly connected with them.	Section through inferior colliculi corp. quad.	Human.	$E_{8\ 4\ 2}$; F_9; G_{11}; H_1; K_5.
	Section through superior colliculi corp. quad. including tegmentum, subst. nigra, cerebral peduncles, corpora mamillaria, optic tract, pulvinar and corpora geniculata.	Human.	$E_{8\ 4\ 2}$; F_9; G_{11}; H_1; K_5.
Diencephalon, Telencephalon and nerves directly connected with them.	Ten coronal sections for macroscopic study through hardened half brain, respectively, 30, 46, 55, 63, 69, 75, 86, 92, 107 and 137 mm. behind frontal pole.	Human.	E_5; F_6.
	Horizontal section for microscopic study including parts between wall of third ventricle and cortex of island of Reil.	Human.	$E_{8\ 4\ 2}$; F_9; G_{11}; H_1; K_5.
	Coronal section for microscopic study through thalamus and hypothalamus, including nucleus hypothalamica (Luysi),	Human.	$E_{8\ 4\ 2}$; F_9; G_{11}; H_1; k_5.
	Sections of cortex for microscopic study:	Human.	$E_{8\ 4\ 2}$; F_9; G_{11}; H_1; K_5. / $E_{8\ 2}$; F_9; G_5; H_1; K_5.
	(1) Upper part of gyrus centralis anterior.		
	(2) Middle third of gyrus temporalis superior.		
	(3) Cuneus adjacent to calcarine fissure.		
	(4) Gyrus fornicatus.		
	(5) Ammon's horn and nucleus amygdalæ.		
	(6) Substantia perforata anterior.		
	(7) Gyrus frontalis inferior (pars opercularis).		
	(8) Gyrus angularis.		
	Finer structure of cortical substance.	Human.	E_4; G_{20}; F_9; h_5; k_5.
	Lobus olfactorius.		
	Transv. section.	Human.	E_4; F_9; G_{11}; H_1; K_5.
	Transv. section.	Rabbit.	E_4; G_{20}; F_9; h_5; k_5.

THE PHOTOGRAPHIC ROOM AND APPARATUS IN THE ANATOMICAL LABORATORY OF THE JOHNS HOPKINS UNIVERSITY.

BY A. G. HOEN, M. D.

The scope of photo-micrography can conveniently be divided into photo-micrography (1) with high powers, (2) with medium powers, and (3) with low powers.

(1) Photo-micrography with high amplification (600 to 1200 diameters) is employed chiefly for the delineation of pathological material, such as micro-organisms, free and in sections of tissues, malarial and leukemic blood, etc., as well as for the demonstration of some of the minuter histological changes which occur in the cells, such as karyokinesis; the demonstration of nerve terminations in the tissues, as well as for the finer histological structures in general.

(2) Photo-micrography with medium amplification (150 to 400 diameters) is applied to tissue work, where it is desirable to differentiate structural elements in pathological as well as in normal histological material, micro-urinary deposits, and the study of vital movements (amœboid) of certain cells by serial exposures. Under this heading it is perhaps well to enter our criticism in reference to the illustrations as found in the various text-books on normal histology. Beautifully as the majority of them are executed, we cannot help but point out their deficiency in properly conveying to the student's mind the correct appearance of the microscopic image or field. It has become a fixed fact in the minds of instructors that teaching histology from drawings and diagrams is by no means altogether satisfactory. Most of the diagrams are selected from exceptionally fine or lucky specimens, and many of them are composite pictures, taken from different slides, the salient points of one being blended with those of others, thus making perfect pictures which have a tendency to puzzle the student, because he cannot verify them from his sections. The diagrams are intended to elucidate the subject, and if they are accompanied with photographs they aid markedly in giving the student the proper impression of the subject at hand, nothing more or less; whilst on the other hand a drawing, no matter how carefully and conscientiously conducted, has constantly mixed with it a certain element, individualism, personal equation, if one chooses, which cannot be eliminated or ruled out. Furthermore the draughtsman never thinks of portraying the imperfections, bubbles of air, dust, cotton fibers, etc., which are likely to be present, even in the best preparations. The very perfection of his drawing is misleading and incorrect.

With a view to eliminating these difficulties, we have made in connection with the histological course, a series of well executed photo-micrographs, taken from the best specimens as prepared and stained by the students themselves. From these photographs lantern slides have been made for projection on a screen. For lower powers than 150 diameters, the specimen itself is utilized for projection by a system of lenses to be described further on.

(3) Photo-micrographs with low powers (from 1 to 100 diameters) applied for the purposes of studying various tissues with reference to their anatomical relations and for injected specimens of whole organs. Also extremely useful in embryological research, in which it has been found of great service as a time-saver to give correct outlines for reconstructions. The above uses of photo-micrography have been kept in mind in purchasing and elaborating the apparatus in the Anatomical Laboratory. Primarily the apparatus was intended for scientific investigation, but in the course of time it was found extremely useful for teaching as well. We shall describe our apparatus under the following heading:

The Rooms.—In constructing the rooms we were guided by the idea that the operator should work within the camera, so we made the main room perfectly dark. This communicates with a room for illuminating purposes on one hand and with a second dark room for developing on the other hand. Of these three rooms, the larger one contains the tables carrying the condensers, microscope, camera and projecting apparatus, whilst the smallest, well lighted one contains the electric arc light and tables for ordinary microscopic observation. The second dark room contains the necessary chemicals for developing plates and conducting such other manipulations as appertain to photography. It is supplied with hot and cold water and is lighted by incandescent lamps, one of which is hooded with black velvet over a frame of asbestos and the lower end is covered by three thicknesses of deep ruby glass. The accompanying figure shows the floor plan of these rooms with some of the apparatus in place. The walls and ceiling of the large room are painted a dull or flat black from which no reflection can take place. The windows are protected against the admission of light by venetian blinds on the outside, an adjustable black cloth one on the inside, and over these, sliding paneled wooden blinds. The inside blinds are also painted black, and are provided with screw clamps for taking up warps in the wood and to ensure perfect contact of their surfaces.

The table bearing the condensers, light filter and microscope is so placed that it directly faces the aperture in the partition, through which the light from the electric arc lamp is projected by the paraboloid reflector to be mentioned further on. The table bearing the camera is so placed that it forms a continuation of the first; both tables are brought into the same plane by means of set-screws.

The tables and camera were made by Zeiss, but we found it necessary to add these set-screws to adjust them to a given plane easily. On the north wall, directly opposite the opening in the partition, a plaster of Paris screen has been made, which is perfectly smooth to ensure a good reflecting surface. This screen is employed to receive the projected image, with low powers, for demonstrating histological specimens themselves to the classes. In addition to this it was found necessary to have a smaller movable screen constructed, which is also adjustable vertically, its use being to adjust the apparatus easily to any given number of diameters in making diagrams and reconstructions.

Illumination.—Sunlight is perhaps the one source of illumination that every photo-micrographer has tried some time in the course of his work, and has been glad to abandon for any new illuminant which would give him practically the same actinic power. There are, however, so many drawbacks to it that it is necessary to observe the time of the year, the day, the hour and the condition of the atmosphere as factors which determine the power of his light, not to say anything of the many disappointing days when it does not shine at all. In our laboratory sunlight has been entirely superseded by the electric arc light, with which we are capable of accomplishing everything desired. The lamp used is the ingenious invention of Coerper, of Ehrenfeld, Germany, and manufactured in America by the Helios Electric Light Co. of Pennsylvania.* The lamp we employ is calculated to be of 4000 candle power, and is run by an alternating current of 30 amperes, and is in no respect dangerous to life. The construction is extremely simple. A glance at Fig. 4 shows the carbon holders balanced by means of a chain over a pulley in the lamp mechanism. As a result of this arrangement with the alternating current, the combustion of the carbons is compensated for by the descent of the upper and the ascent of the lower carbon in exactly the same ratio, and the arc is thus fixed practically at one point, and remains there from the time the current is turned on until the carbons are consumed. We found it necessary to substitute for the upper porcelain reflector one made in the form of a paraboloid, which completely encloses both carbon points. Our reflector is made of one piece of copper, lined on the inside with a thick coating of white lime, and our experience with it convinces us that it has very markedly increased the power of the light. In order to easily adjust the lamp in the optical axis of our photo-micrographic apparatus, we adopted the plan of mounting it on a mechanical stage, made much after the pattern of that employed on the better class of microscopes. This frame is attached to the wall in an upright position, thus giving both vertical and lateral movements, and we find that it works admirably, and is capable of adjusting the lamp to the fraction of an inch. These alterations and modifications were made by Messrs. Murrill & Keizer of Baltimore, to whom we are very much indebted for advice and suggestions in reference to the same. In attaching the parabolic reflector to the lamp, the carbon points were made to pass through two openings in it in order to keep them in place. Experience showed us, however, that there was considerable vibration of the two points in spite of this, which we overcame by attaching a guard to the side of the lamp, to steady the upright rod of the lower carbon point. This guard is adjustable with a screw, as the figure shows. With these adjustments we succeeded in attaining a source of light which is not continually moving up and down, as in the case of the lamp furnished by Zeiss. The heat generated by this lamp is considerable, and it was found necessary to protect the mechanical stage and the surrounding woodwork by asbestos sheeting.

Apparatus and Accessories.—The apparatus consists of a Zeiss stand I^{a} for photo-micrography with 2, 2.5, 4, 8, 16, 35, and 70 mm. lenses and Nos. 2 and 4 projection oculars. In addition to these lenses, there are also the following photographic lenses which can be used for photographing with low powers as well as for ordinary lantern projection:

Anastigmat 1:	6.3,	focus	43	millimeters.
1:	7.2,	"	96	"
1:	7.2,	"	148	"
1:	12.5,	"	260	"
1:	18,	"	632	"

With these lenses it is possible to photograph objects from one diameter upwards, and this is very necessary, for it is often desired to obtain a specific enlargement of a specimen, as in reconstruction work.

In addition to these lenses there is a complete projection table

* McKay-Howard Electric Construction Co., Baltimore, Md.

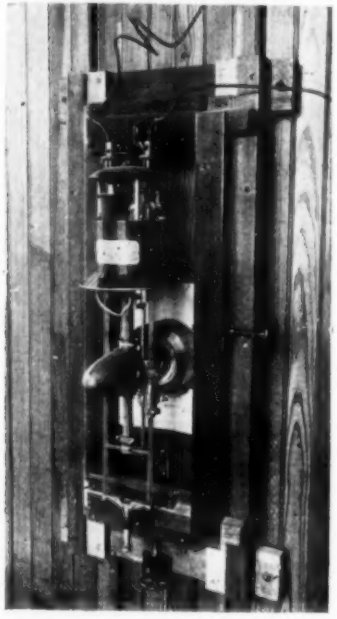

FIG 4. HELIOS ELECTRIC LAMP ATTACHED TO THE NORTH WALL OF THE OBSERVATION ROOM.

The position of the lamp is indicated by the * on the ground floor plan.

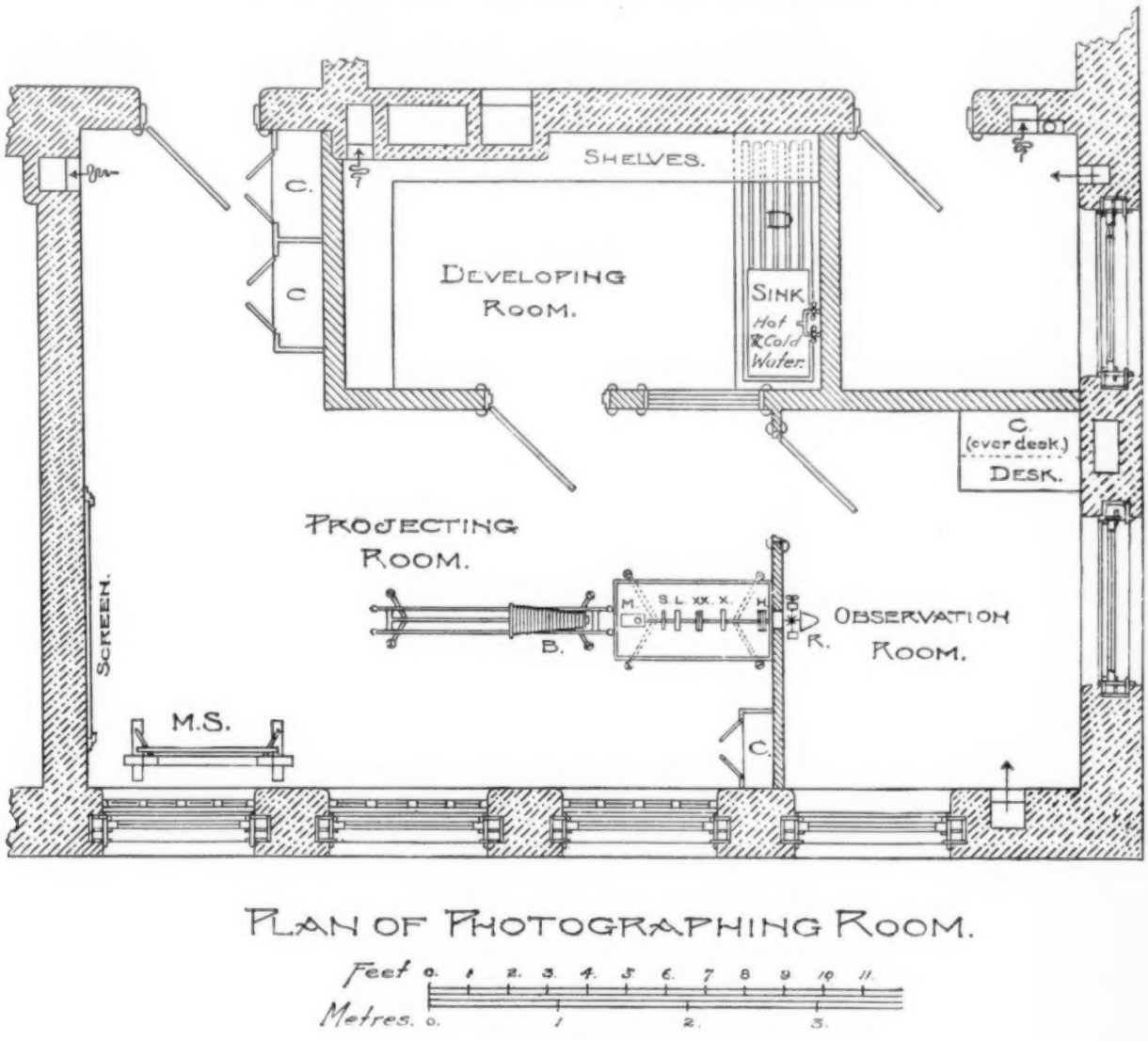

FIG. 1.

C, Cases. *D*, Drip-board. *MS*, Movable screen. *B*, Bellows. *M*, Microscope. *S*, Specimen holder. *L*, Light filter. *xx*, Double convex lens. *x*, Plano-convex lens. *H*, Heat filter. *, Electric light. *R*, Reflector.

FIG. 2. SOUTH-WEST CORNER OF THE PROJECTING ROOM.

Flash-light photograph. The light is in the next room as indicated in the ground floor plan.

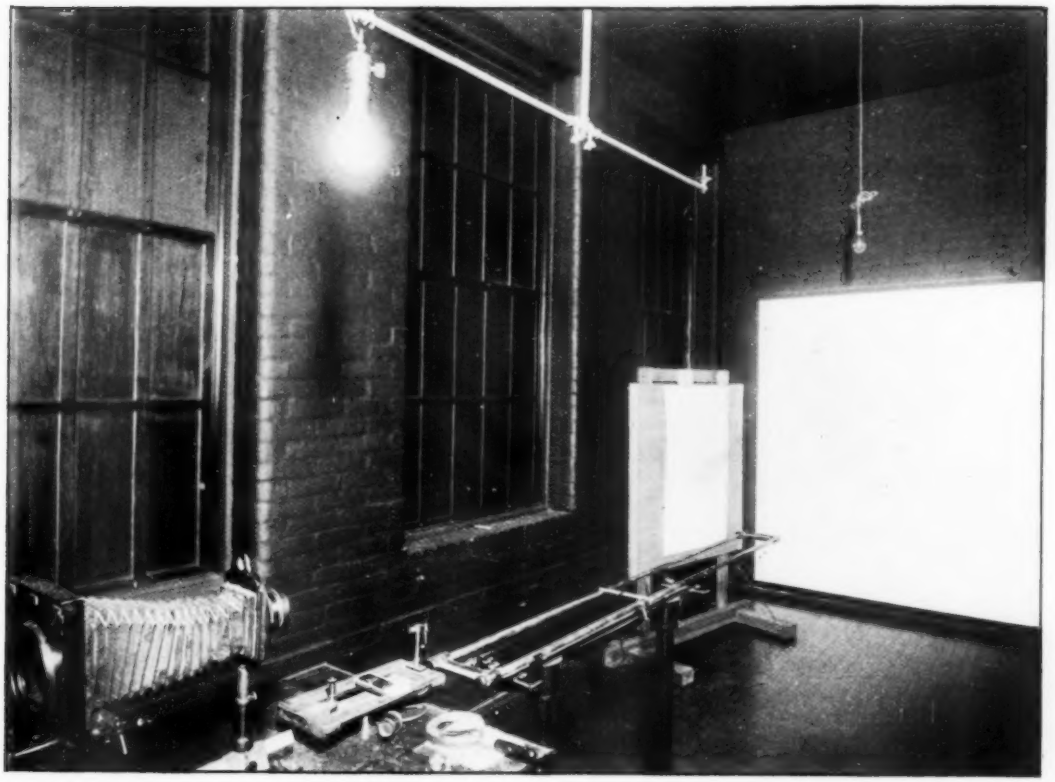

FIG. 3. NORTH-WEST CORNER OF THE PROJECTING ROOM.

The permanent screen is attached to the wall for ordinary projecting work with either high or low powers. The movable screen is employed when a definite number of diameters are desired, as in making charts, bromides, or simple outline drawings upon wax plates. On the left of the figure is the magic lantern adjustment attached to the Zeiss stand.

with its appendages, as well as the large camera. For delicate work there is a spectral illuminating apparatus after Hartnack.

The anastigmat lenses are all interchangeable, and the large ones are fitted with a prism to photograph at right angles to the object, as is often necessary in photographing objects under fluids. The sub-stage of the condenser of the microscope is that constructed after the formula of Prof. Abbé, is achromatic and supplied with two iris diaphragms, by which the access and egress of light may be regulated to the requirements of the amplification to be used, or in other words, they permit the use of the entire aperture of the condenser or only fractional portions thereof, as the case may be. It is fitted with two adjusting screws, by which means the condenser may be accurately centered for the objective in use, and an even and uniform illumination of the field secured.

As two tables or stands are supplied with this apparatus, one bearing the condensers, light filter and sole plate for the microscope, and the other the camera, we found that it was impossible to bring both tables to an exact level with each other or to retain them there, in consequence of which it was also impossible to establish a perfect optical line between the former and the latter. We found an adequate remedy for this by having set-screws put into each one of the iron pedestals of the tables; these screws rest in small metallic discs, which are simply laid on the floor in their proper position. This improvement of the Zeiss table has been found very serviceable in leveling the tables from time to time.

Methods of Illumination for High and Medium Powers.—1st Method: In order to illustrate this it is necessary to refer to Fig. 1. The star represents the arc light, the rays of which are received upon the plano-convex lens *x*, which is so placed that the arc is in its principal focus, thus rendering all rays passing through it, parallel. In their further course through the bi-convex lens *xx* the rays are brought to a focus, which is made to coincide, by adjusting this lens on the sliding bar, with the principal focus of the lower lens of the Abbé condenser in the microscope (*M*). The lower lens of the Abbé condenser renders the rays parallel, while its second lens converges them and brings them to a focus in the plane of the object, giving there a small but very bright image of the source of illumination.

2d Method: This consists in the use of a plano-convex lens of much shorter focus than the one supplied with the outfit. It was made for us by Messrs. Bausch & Lamb of Rochester, N. Y., and is mounted in a metal frame which is fastened to the wall, and by means of set-screws permits of perpendicular as well as lateral movements. The collar is also movable in the optical axis, so that the distance between the collecting lens and the light can be regulated with ease. The lens is four inches in diameter and its principal focal distance is five inches. Its adjustment for accurately focusing the lamp is accomplished by means of the set-screw, which is moved back and forth until a bright beam of light, not greater in diameter than the lens itself, is projected on the screen. Fig. 4 of the lamp shows the lens as having been pushed through the opening in the partition by means of the set-screw and in position for focusing the lamp.

In order to accurately center the Abbé condenser for the objective system we have adopted the following plan: The condenser is racked down far enough to enable us to unscrew its top cap which carries the small, nearly hemispherical and the upper achromatic plano-convex lenses of the system. This discloses the iris diaphragm situated immediately below it, the aperture of which is now reduced to its smallest diameter by the regulating lever of this part of the condenser. The resulting small opening is now carefully brought into the focus of a weak objective (16 mm.) and a low eyepiece (No. 4), and by means of the centering screws attached to the condenser, lateral and vertical movements are imparted to the latter until the opening in the diaphragm occupies a central position in the visual field of the microscope. We may state here that all of our objectives are carefully centered to the optical axis by Zeiss' "sliding objective changer."

To center the source of illumination to the optical axis the following was found to be the speediest and most certain method in our hands: The lenses of the guide-bar as well as those of the microscope, including the Abbé condenser and eyepiece, are removed; a pin-hole diaphragm is now placed in an eyepiece (freed of its lenses), which is slipped into the tube of the microscope. By looking through the pin-hole opening in the blank eyepiece, the carbon points of the electric arc light (without current) can now be brought into view by means of the adjusting screws on the mechanical stage bearing the lamps, to occupy a position corresponding to the opening in the diaphragm in the eyepiece. Once so adjusted the lamp has a tendency to remain in this position, requiring perhaps one adjustment in the course of six hours use.

The lenses for rendering the light parallel and condensing it are now placed upon the guide-bar and so adjusted that a sharp and bright image of the burning carbons is projected exactly in the center of the lower iris diaphragm of the Abbé condenser, which is closed to its utmost for this purpose.

For very high powers (immersion systems) the whole aperture of the Abbé condenser is utilized by opening the iris diaphragms to their fullest extent; for medium powers about one half of this aperture is sufficient. We found in practice that the illumination of the object which gave the most clear and sharp picture visually also answered the best purposes for photography. To secure the best illumination, the condensing lens *xx* is moved back and forth upon the guide-bar until the projected image of the microscopic field upon the ground glass of the camera is brightest and most evenly illuminated, thus fixing the position for the lens *xx*, for the focus of this lens and of the lower lens of the Abbé condenser are now coincident.

Light Filter.—We have confined ourselves exclusively to the bichromate of potash and sulphate of copper solution as recommended by Neuhaus in his admirable work on Photomicrography (p. 64, 1890). It is made as follows:

Sulphate of copper, 175 grams.
Bichromate of potash, 17 grams.
Sulphuric acid, 2 cc.
Water, from 500 to 1000 cc.

The more concentrated solution is applicable to specimens stained very lightly with the various blues (hæmatoxylon,

anilines, etc.) or for the reds, particularly safranin preparations. Eosin is a decidedly disturbing element in photomicrography, and unless it is very cautiously and lightly used, as a counter-stain to other dyes, produces an indefinable haze or indistinctness upon the plate which mars an otherwise good negative very much. As practically no heat rays permeate this solution, it answers the purpose of a heat filter thoroughly. The position of the light filter is of little moment, provided that the rays of light which pass through it are the only ones which reach the Abbé condenser.

Focusing.—With a camera length of 55 to 60 cm. we have rarely found it necessary to have recourse to any special focusing appliance; the fine adjustment is within reach of the hand, while watching the appearance of the image on the ground glass. The focusing glass we employ is an ordinary hand lens, with which most of our work requiring from 150 to 400 diameters is accomplished.

The plate for intercepting the image is made of finely ground glass, such as Zeiss supplies with his outfit. For bacterial work a plane glass screen is used in connection with Zeiss' focusing lens, which is adjustable to the eye of the operator.

When the long camera is employed we use the focusing rod and Hooke's key as furnished with the Zeiss outfit.

Plates.—After using the plates of a number of manufacturers, we have selected those made by the "Cramer Dry Plate Company" of St. Louis, Mo., as those which give us uniformly the best results.

They are orthochromatic in the widest sense, are very uniform, and the instantaneous or extra rapid plates made by this company are sensitive to an exquisite degree.* For bacterial work we use the latter (1000 to 1200 diameters), preferring the "medium" plates for histological purposes (150 to 400 diameters).

*From two to five seconds exposure is sufficient to impress these plates, even under such great dispersion of light as takes place, for instance, with the 2 mm. immersion system of 1.40 N. A. The advantages of this short exposure are obvious.

The development of these plates is accomplished as advised by, and after the formula of the manufacturers (in their circular), by a combination of hydroquinone and eikonogen. Care is necessary in manipulating these plates in the dark room with reference to the light used, which must be of a deep ruby red and feeble, otherwise they will fog. It is safer to develop the plates away from the light, using the latter only occasionally to watch the progress of the development.

Determination of Amplification and Means of Measurement.—With the Zeiss system of objectives and projection oculars, we have adopted the plan as advocated by him in his "Special Catalogue," (p. 36), and also noted in Neuhaus' work before referred to (p. 72).

As Zeiss has adopted a nomenclature for his objectives and oculars by designating them by their focal distances, it is an easy matter to arrive at the magnifying power of any one combination of objective and projection ocular by having recourse to the following formula:

$\frac{L}{O} \times P = x$— in that L represents the camera length, O the focal distance of the objective, and P that of the projection ocular.

If therefore an objective of 2 mm. focal distance and the projection ocular No. 4 be used in combination with a camera length of 550 mm., we shall have:

$$\frac{550}{2\text{ mm.}} \times 4 = \frac{1100}{1}\text{ linear.}$$

In this calculation the reckoning must be made from the shoulder of the ocular to the ground glass or screen. In those instances where it is necessary to be extremely accurate in the measurements, the stage micrometer ruled in 10ths and 100ths of a millimeter is made use of. Reproduction $= x$.

Yet for accurate work it is always necessary to control by projecting a millimeter scale. These we have had ruled in square millimeters, in square tenths and hundredths. For careful reconstruction work this is very necessary, as a projected rule shows easily any irregularity in the amplification at the periphery of the field.

ADENO-MYOMA OF THE ROUND LIGAMENT.

By Thomas S. Cullen, M. B. (*Tor.*), *Instructor in Gynecology in the Johns Hopkins University, Assistant Resident Gynecologist to the Johns Hopkins Hospital.*

Isolated cases of adeno-myomata of the uterus have been from time to time reported, and recently our interest in these cases has been awakened by the excellent work of v. Recklinghausen, "Die Adenomyome und Cystadenome der Uterus und Tubenwandung," and within the last few months we have had two cases in the Johns Hopkins Hospital.

While adeno-myomata of the uterus are not so rare, similar tumors of the round ligament have apparently never been reported.

Leopold described a cystic myoma of the R. ligament. The writer, after carefully examining the tumor microscopically, came to the conclusion that the cyst cavities were dilated lymph spaces.

Aschenborn, in a patient with phthisis, found a tumor the size of a walnut lying in the inguinal canal and springing from the R. ligament. It was a thick-walled cyst, and contained clear transparent fluid. The microscopic appearances were not described.

Coulson had a case closely resembling that of Aschenborn. Roustan describes a case observed by Duplay. Situated over the external ring was a tumor twice the size of a man's fist. This on section resembled a cystic testicle. Microscopically the solid portions consisted of non-striped muscle, adipose and connective tissue. Some of the cyst-like spaces were traversed by trabeculæ. None of the cavities presented any epithelial lining. The tumor was a myoma undergoing degeneration.

ADENO-MYOMA OF THE ROUND LIGAMENT.

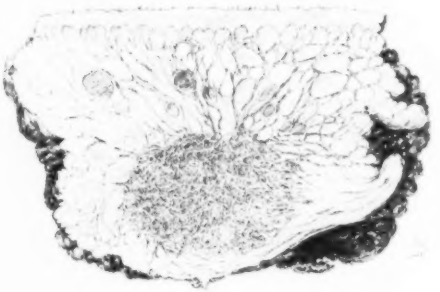

Fig. 1.

NATURAL SIZE. LONGITUDINAL SECTION OF THE TISSUE REMOVED. THE UPPER PORTION IS SKIN. THE GREATER PART OF THE SPECIMEN CONSISTS OF LOBULES OF FAT. THE ROUND OR OVAL DARK AREAS IN THE FAT ARE HEMORRHAGES. SITUATED IN THE ADIPOSE TISSUE IS THE TUMOR, WHICH CONSISTS OF MUSCLE BUNDLES. SCATTERED HERE AND THERE THROUGHOUT THE MUSCLE ARE ROUND OR IRREGULAR DARK SPACES. THESE REPRESENT THE DILATED GLAND CAVITIES. RUNNING INTO THE MYOMA FROM ALL SIDES ARE STRANDS OF CONNECTIVE TISSUE.

Fig. 2.

SIXTEEN TIMES ENLARGEMENT OF A PORTION OF THE ADENO-MYOMA. THE SPECIMEN CONSISTS CHIEFLY OF NON-STRIPED MUSCLE FIBRES. IN THE RIGHT LOWER CORNER ARE MASSES OF FAT CELLS. NEAR THE LEFT LOWER CORNER ARE SEVERAL FAT CELLS. IN THE VICINITY OF THE LEFT UPPER CORNER IS A PSEUDO-GLOMERULUS. THIS IS COMPOSED OF STROMA, SCATTERED THROUGHOUT WHICH ARE CROSS SECTIONS OF SEVERAL GLANDS. THE SURFACE OF THE GLOMERULUS IS COVERED BY ONE LAYER OF CYLINDRICAL EPITHELIUM. ITS CAPSULE IS COMPOSED OF ONE LAYER OF CELLS WHICH IN PLACES ARE CUBOIDAL OR ALMOST FLAT. THE CELLS OF THE CAPSULE HAVE PRACTICALLY NO UNDERLYING STROMA BUT LIE DIRECTLY ON THE MUSCLE FIBRES. THE SPACE BETWEEN THE PSEUDO-GLOMERULUS AND THE CAPSULE IS, ON TRACING IT TO THE RIGHT, SEEN TO BE CONTINUOUS WITH A GLAND CAVITY, AND IS NOTHING MORE THAN A DILATED PORTION OF THE GLAND. ABOVE AND TO THE RIGHT OF THE PSEUDO-GLOMERULUS ARE CROSS SECTIONS OF TWO GLANDS. BELOW IT ARE SEVERAL LONGITUDINAL SECTIONS OF GLANDS. ONE SHOWS DICHOTOMOUS BRANCHING. ALL OF THE GLANDS ARE SURROUNDED BY STROMA, WHICH SEPARATES THEM FROM THE MUSCLE.

The above are the reported cases which at first sight might bear some semblance to the case I report.

CLINICAL HISTORY.

L. N., æt. 37, admitted in the service of Dr. Kelly, Oct. 18th, 1895.

The patient has been married 13 years; had one instrumental labor 7 years ago. Her menses commenced at 14, and were regular until the birth of the child, since which time they have occurred every 3 weeks, have been very copious, and have lasted from 4 to 5 days. The latter part of each period has been accompanied by a good deal of pain, which persists for several days after the flow ceases. Last menstrual period two weeks before admission.

Family History.—Her father died of paralysis; one aunt and her grandmother died of carcinoma.

Present Trouble.—About 8 years ago the patient noticed a slight swelling in the right inguinal region. This has gradually enlarged, especially during the last 2 years. She has experienced severe cutting pain in the nodule. The pain radiated to her back, and was most severe after exertion or at the menstrual period. The patient is debilitated; her appetite is moderate; bowels regular. She has a thick white or yellowish leucorrheal discharge. This is non-irritative, and is not offensive.

Vaginal examination is negative.

The mass occupies the upper part of the right labium. It is irregularly ovoid, and is firmly fixed in the deep tissue; it is, however, movable to the extent of 1 cm.

Operation by Dr. Kelly, Oct. 19, 1895.—An oval incision was made over the site of the nodule. The mass was freed laterally and posteriorly. Above, it was closely connected with a band of tissue 1 cm. broad. This proved to be the right round ligament. The round ligament was traced upward to the internal ring. Midway between the external and internal ring it contained a nodule 1 x .6 cm. in diameter. The round ligament was pulled down, clamped and cut off at the internal ring. Several enlarged lymph glands were then dissected out. The pillars of the ring were brought together by silver wire sutures. The round ligament was sutured into the canal. The canal throughout its entire extent was closed by mattress sutures of silver wire. The incision was then closed with catgut. The patient was discharged on Nov. 3d.

ANATOMICAL APPEARANCES.

Pathological No. 928. The specimen consists of a piece of tissue 7 x 4 x 3.5 cm. One surface of this is covered by normal skin, the underlying tissue is composed of fat, embedded in which is an exceedingly firm nodule 3.5 x 3 x 2 cm., Fig. 1. This nodule on section is composed of interlacing bundles of fibres which form a dense network. Scattered throughout the nodule are many small irregular, pale, translucent, homogeneous areas. On examining the specimen after hardening in Müller's fluid, some of the homogeneous areas are found to contain round, oval or irregular spaces. Accompanying the specimen are several lymph glands, one of which is 1 x .8 cm.

HISTOLOGICAL EXAMINATION.

The nodule is to a great extent composed of non-striped muscle fibres which wind in and out in all directions, but do not show any concentric arrangement. In many places the muscle fibres are swollen, and the cell protoplasm contains large quantities of yellowish-brown granular pigment. At several points the muscle has undergone hyaline degeneration. This is especially noticeable around blood-vessels. The blood supply is abundant. Scattered here and there throughout the muscle substance are small islands of adipose tissue. *Traversing the nodule in all directions are glands*, Fig. 2. Some of these are small and round on cross section, others are cut lengthwise. These glands are surrounded by stroma similar to that of the uterine mucosa. It would be impossible to distinguish some of these from uterine glands. A few of the glands present slight dichotomous branching. Some of the glands contain round masses of protoplasm, scattered throughout which are several nuclei. These giant cells appear to be cross sections of tufts of epithelium.

In many places the glands present a peculiar arrangement and correspond to v. Recklinghausen's pseudo-glomeruli. These pseudo-glomeruli consist of stroma resembling that of the uterine mucosa. They contain numerous capillaries and may have one or more glands situated in their depth. In some places there is hemorrhage into their stroma. The pseudo-glomeruli are half-moon shaped, cone-shaped or irregular in contour. They are covered by one layer of cylindrical ciliated epithelium. What corresponds to Bowman's capsule consists of a layer of cells resting directly upon the muscle fibres. The cells of the capsule opposite the convexity of the glomerulus are almost flat; on passing off laterally they are seen to be cuboidal or cylindrical. The cells of the so-called capsule are directly continuous with those of the pseudo-glomerulus. The space between the capsule and the glomerulus may be empty; many, however, contain desquamated epithelial cells, some of which are vacuolated and contain brown granular pigment. Numerous spaces contain red blood corpuscles. On tracing one of the spaces laterally it is found to be directly continuous with the lumen of a gland. The capsule forms one wall of the gland and the pseudo-glomerulus the other, Fig. 2. In other words, the space between the capsule and the so-called glomerulus is nothing more than a dilatation of the gland cavity. In numerous places the gland epithelium on one side is found to be cylindrical, on the other side cuboidal or almost flat. On examining this more closely it is found that where the epithelium is separated from the muscle by a moderate amount of stroma it is cylindrical, but that where the epithelium rests directly upon the muscle it is invariably cuboidal or flat.

A few small glands are seen lying directly between muscle bundles. Extending into the myomatous growth from the periphery are numerous bands of connective tissue. The adipose tissue surrounding the myoma shows considerable hemorrhage. The skin covering the surface of the specimen is normal. The lymph glands, apart from being somewhat swollen, are normal.

Unfortunately we were not able to obtain the smaller

nodule of the round ligament for examination, and cannot say whether it was an adeno-myoma or not.

From a clinical standpoint the excessive pain in the nodule at the menstrual period is significant. It leads to the belief that there was some definite sympathetic relation between the uterus and the nodule in the round ligament.

Both v. Recklinghausen and I considered adeno-myomata of the uterus non-malignant, and the fact that the nodule in this case existed for eight years and increased very slowly, and at the operation showed no evidence of malignancy, strengthens our belief that these tumors are benign.

The only case in the literature that throws any light on this case is the one reported by A. Martin. A patient, æt. 70, consulted him about a rapidly growing tumor. He opened the abdomen and removed 12 litres of chocolate-colored fluid from the tumor which presented at the incision. This growth sprang from the left R. ligament, being connected with it by a pedicle. Pommorsky, who made the microscopical examination, found that the cyst containing the chocolate-colored fluid had very thin walls and that its inner surface was in places covered by clots. The pedicle of the tumor contained several small cysts which were filled with clear fluid and which communicated with one another. One of these cysts was lined by low cylindrical ciliated epithelium. Martin says that in this case the structure and contents corresponded to those of tumors arising from the parovarium.

Origin of the Glands.

The glandular elements in our case correspond very closely to those found by v. Recklinghausen in adeno-myomata of the uterus. In those cases he was able to trace a marked resemblance between the tumor glands and remains of the Wolffian body, and came to the conclusion that the glands were derived from this source. While admitting the probability of the glands in our case being due to remains of the Wolffian body, we cannot, from their striking resemblance to those of the uterine mucosa, and from the fact that their stroma resembles that of the mucosa, refrain from suggesting the possibility that they may be due to an abnormal embryonic deposit of a portion of Müller's duct.

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A LIST OF SCIENTIFIC MEDICAL JOURNALS IN PUBLIC AND PRIVATE LIBRARIES OF BALTIMORE.

Compiled by Miss E. S. Thies.

This journal catalogue contains most of the periodicals contained in the libraries (see below) of Baltimore. In preparing this list it has been the aim to include only those journals and society proceedings which contain papers of scientific value. Although journals somewhat remote from scientific medicine and biology have been included in this list, many medical journals have been omitted. The list is primarily intended as a reference list; it does not contain the popular science journals nor journal sets, which are very fragmentary.

ABBREVIATIONS.

Anat.,	Anatomical Laboratory.
Biol.,	Biological Laboratory.
Chem.,	Chemical Laboratory.
Dr. Flexner,	Dr. Flexner's Library.
Dr. Halsted,	Dr. Halsted's Library.
J. H. Hospital,	Johns Hopkins Hospital.
J. H. University,	Johns Hopkins University.
Dr. Hurd,	Dr. Hurd's Library.
Dr. Kelly,	Dr. Kelly's Library.
Dr. Mall,	Dr. Mall's Library.
M. C. F.,	Medical and Chirurgical Faculty.
Dr. Osler,	Dr. Osler's Library.
Path.,	Pathological Laboratory.
Peabody,	Peabody Institute.
P. L.,	Pratt Library.
Phar.,	Pharmacological Laboratory.
Dr. Welch,	Dr. Welch's Library. F. P. Mall.

A

Abhandlungen der königlichen Gesellschaft der Wissenschaften zu Göttingen.
J. H. University, v. 1-38, 1841-92.

Abhandlungen der königlichen Akademie der Wissenschaften zu Berlin.
J. H. University, 1890-95. (?)

Abhandlungen der königlichen Gesellschaft der Wissenschaften zu Leipzig.
J. H. University, 1876- .
Dr. Mall, 1887- .

Abhandlungen der Berliner Akademie.
J. H. University, 1804-79.

Abhandlungen der mathematisch-naturwissenschaftlichen Classe der königl. böhmischen Gesellschaft der Wissenschaften.
J. H. University, 6 F. v. 12. 7 F. v. 1-4.

Abhandlungen der mathematisch-physischen Classe der Münchener Akademie der Wissenschaften.
Peabody, 1835-86.

Abhandlungen der naturwissenschaftlichen Gesellschaft Isis in Dresden.
J. H. University, 1885-86.

Acta de l'Académie impériale des sciences de St. Pétersbourg.
Peabody, 1777-1802.

Actes de la Société helvétique des sciences naturelles.
See Verhandlungen der schweizerischen naturforschenden Gesellschaft.

Actes de la Société scientifique du Chili.
J. H. University, v. 1- , 1891- .

Alienist and Neurologist.
Dr. Hurd, v. 1- , 1880- .
M. C. F., v. 3- , 1882- .
J. H. Hospital, v. 4-10, 1883-89.

Allgemeines Journal der Chemie.
Chem. 1798-1810.

American Anthropologist.
J. H. University, v. 1- , 1888- .

American Chemical Journal.
Chem., v. 1- , 1879- .
P. L., v. 1- , 1879- .

American Gynaecological and Obstetrical Journal.
Dr. Kelly, v. 1- , 1891- .

American Journal of Conchology.
J. H. University, v. 1-7, 1865-72.

American Journal of Insanity.
Dr. Hurd, v. 1- , 1844- .
J. H. Hospital, v. 39-47, 1882-91.

American Journal of Microscopy and Popular Science.
J. H. University, v. 1-6, 1876-81.
Biol., v. 1-4, 1876-79.

American Journal of Neurology and Psychiatry.
J. H. Hospital, v. 1-3, 1882-84;
Dr. Hurd, v. 1-3, 1882-84.

American Journal of Obstetrics.
Dr. Kelly, v. 1- , 1868- ;
M. C. F., v. 3- , 1871- ;
J. H. Hospital, v. 24- , 1891- .

American Journal of Psychology.
Dr. Hurd, v. 1- , 1887- ;
M. C. F., v. 1- , 1887- ;
J. H. University, v. 1- , 1887- .

American Journal of Science and Arts.
J. H. University, v. 1- , 1819- ;
P. L., v. 1- , 1819- .

American Journal of the Medical Sciences.
J. H. Hospital, v. 1-26, 1827-40. N. S., v. 1- , 1841- ;
M. C. F., v. 1-26, 1827-40. N. S., v. 1- , 1841- ;
Dr. Halsted, v. 1-26, 1827-40. N. S., v. 1- , 1841- ;
Dr. Welch, 1888- .

American Medical Recorder.
J. H. Hospital, v. 4-15, 1821-29.

American Naturalist.
J. H. University, 1- , 1868- .

American Public Health Association (Public health reports and papers).
J. H. Hospital, v. 1-12, 1873-87.

Anatomische Hefte.
Anat., v. 1- , 1891- .
Dr. Mall, 1-3, 1892-93;
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Anatomischer Anzeiger.
Dr. Welch, v. 1- , 1886- ;
Biol., v. 1- , 1886- ;
Dr. Mall, v. 1- , 1886- ;
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Annalen der Chemie und Pharmacie.
Peabody, 1832- .

Annalen der Pharmacie.
Chem., v. 1- , 1832- .

Annalen der Physik und Chemie.
Peabody, 1799-1826.
J. H. University, 1824- .
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Ergänzungsheft, 1-7, 1842-76.

Annalen des kaiserlich königlich naturhistorischen Hofmuseums zu Wien.
J. H. University, v. 1- , 1886- .

Annalen des Museums der Naturgeschichte zu Wien.
Peabody, 2 v., 1836.

Annales de chimie et de physique.
Peabody, 1816- .

Annales de chimie ou recueil de mémoires concernant la chimie et les arts qui en dépendent.
Chem., 1789- .

Annales de gynécologie et d'obstetrique.
Dr. Kelly, v. 1- , 1874- .

Annales de la faculté des sciences de Marseille.
J. H. University, v. 1-4, 1891-94.

Annales de l'institut botanico-géologique de Marseille.
J. H. University, v. 1- , 1893- .

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Dr. Welch, v. 1- , 1887- ;
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Biol., 1874- .

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Dr. Hurd, 1843-89.
J. H. Hospital, 1855-64; 1890- .

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J. H. Hospital, v. 1-8, 1878-83.

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Dr. Kelly, v. 1- , 1887- .

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Chem., v. 1-10, 1813-17.

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J. H. Hospital, v. 1- , 1885- ;
Dr. Kelly, v. 1- , 1885 ;
M. C. F., v. 1- , 1885- .

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J. H. University, v. 1- , 1878- ;
Peabody, 1879-86.

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Dr. Welch, v. 1, 1895.

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Dr. Welch, v. 1- , 1885- .

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Dr. Welch, v. 1, 1891.

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Biol., 1874-88.

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Peabody, 1834-96.

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Dr. Osler, v. 1- , 1847- .

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Pathol., v. 1-8, 1875-82.

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J. H. Hospital, v. 6-7, 1887.

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Peabody, 1868- ;
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5 S., v. 1- .

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5 S., v. 1- .

B

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See Jahresbericht über die Fortschritte in der Lehre von den pathogenen Mikroorganismen, etc.

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Biol., v. 1-6, 1876-93.

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Dr. Welch, Pts. 1-2, 1846.

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Dr. Halsted, v. 1- , 1885- ;
J. H. Hospital, v. 8- , 1891- .

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Dr. Welch, v. 1- , 1886- .

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Dr. Mall, 1865-75.

Berichte und Monatsberichte der Berliner Akademie.
J. H. University, 1839-81.

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J. H. Hospital, v. 1- , 1864- ;
M. C. F., v. 18- , 1881- ;
Dr. Welch, v. 25- , 1888- ;
Dr. Halsted, 1882-86.

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J. H. University, v. 1-3, 1877-86.

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Dr. Mall, N. S., v. 1- , 1881- .

Biologisches Centralblatt.
Biol., v. 1- , 1881- .

Boston Medical and Surgical Journal.
J. H. Hospital, v. 12-18, 1835-38; v. 26-37, 1842-48;
v. 45-48, 1851-53; v. 92- , 1875- ;
M. C. F., v. 26-37, 1842-47; v. 52, 1855; v. 55- , 1857-
(v. 63, 1860; 68, 1863; 71, 1865; 85, 1871 *missing*).
Dr. Halsted, 1882-85.

Botanical Gazette.
Biol., v. 10- , 1885- .

Botanische Zeitung.
Biol., v. 34- , 1876- .

Botanischer Jahresbericht.
Biol., v. 1-7, 1873-79.

Brain.
Dr. Hurd, v. 1- , 1878- ;
J. H. University, v. 1- , 1878- ;
M. C. F., v. 1- , 1878- ;
P. L., v. 1- , 1878- .

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J. H. Hospital, 1840-51.

British and Foreign Medico-Chirurgical Review.
Dr. Welch, v. 1-59, 1848-77;
J. H. Hospital, v. 1-43, 1848-69;
M. C. F., v. 1-14, 1836-42; v. 18, 1844; v. 22-24, 1846-47.

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J. H. University, 1861-90.

British Journal of Dermatology.
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J. H. Hospital, 1878, v. 2- ;
M. C. F., 1876- ;
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Peabody, 1860-81.

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Dr. Welch, N. S., v. 3-9, 1885-91.

Bulletin de la Société Belge de geologie, de paleontologie et d'hydrologie.
J. H. University, v. 2-7.

Bulletin de la Société chimique de Paris.
Chem., 1864-93.

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J. H. University, v. 17-20, 1889-92.

Bulletin de la Société zoologique de France.
Biol., v. 1-18, 1876-93.

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J. H. University, v. 1-4, 1882- .

Bulletin général de thérapeutique.
M. C. F., v. 106- , 1884- .

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Dr. Welch, v. 1- , 1887- .

Bulletin of the Buffalo Society of Natural Sciences.
J. H. University, v. 2- , 1874- ;
Peabody, v. 2-3, 1874-77.

Bulletin of the Illinois State Laboratory of Natural History.
J. H. University, v. 1-4, 1876-92.

Bulletin of the Museum of Comparative Zoology at Harvard College.
J. H. University, 7- , 1880- ;
Peabody, 1863-76.

Bulletin of the Natural History Society of New Brunswick.
J. H. University, Nos. 4-12, 1885-92.

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J. H. University, 1-7, 1885- .

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Peabody, 1837-42.

Bullettino della Reale Accademia Medica di Roma.
J. H. Hospital, 1889- ;
Dr. Thayer, 1890- .

Bullettino della Societa Veneto Trentina di scienze naturali.
J. H. University, v. 3- , 1885- .

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Dr. Kelly, v. 1- , 1885- .

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J. H. University, v. 1- , 1881- .

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J. H. University, 1832- .

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J. H. University, v. 15, 1885.

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J. H. University, v. 17-21.

C

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J. H. University, 1- , 1822- .

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Dr. Osler, v. 1- , 1890- ;
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J. H. Hospital, v. 5- , 1895- .

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